Department of Business & Management

Corporate Strategies

Artificial Intelligence:
towards a new economic paradigm

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Introduction

Artificial intelligence (AI) is finally providing a multitude of competencies to machines which were long thought to belong exclusively to the humans. Today intelligent computers are able to process natural language or visual information, making decisions, interacting with humans and external environment autonomously. The range of machines capabilities is continuously expanding while their artificial minds become always more similar to the human brain.

While the concept of AI dates back more than 50 years, only recently technological advances enabled successful development and implementation at industrial scale. The diffusion of AI is driving work automation and is changing the way companies operates. The economic potential is massive, it is esteemed $15.7 trillion, 14 percent of the world GDP, is the value of economic benefit deriving from AI by 2030. Some experts have described the rise of AI-driven automation as one of the most important economic and social developments in history. The World Economic Forum has considered it as the lynchpin of a Fourth Industrial Revolution. At the same time, serious challenges and concerns are emerging about biases and distortive effects. In recent years, machines have exceeded humans in the performance of numerous tasks related to intelligence. This trend is likely to continue and the range of fields in which machines outperform human workers will increase. This means that AI-driven innovation will create wealth and growth for the economy but it has the potential to disrupt the lives of millions of people.

The aim of this research is to investigate which are the opportunities and the threats of AI innovation on companies and the economic environment. This report examines the expected impact of intelligent machines on the economy and describes broad strategies that could increase the benefits of AI and alleviate its costs. In particular, how the AI disruptive force will impact the global economy and its own structure. Furthermore, the research is aimed to evaluate whether structural changes are required in the economic paradigm in order to adapt to the new technologic radical changes. The analysis assesses

the extent and the implications for the AI disruption from the single business perspective to the larger macroeconomic implications.

In the first part, it is necessary for defining what artificial intelligence means, which are its applications and what are the drivers that enabled its development in the last years. While the first researches on intelligent machines date back to the ’40, only in the last decade artificial intelligence is developing. The reason is related to the increased availability of data, the decrease of storage cost per byte, the improved computing power and algorithms. Anyway, artificial intelligence is a set of technologies that provide computers with cognitive skills, such as problem-solving, decision making, reasoning, as well as voice, image, and language recognition, which typically belong to human beings. In the last decade, technologies evolved towards the fundamental human cognitive skills. While always more complex algorithms are able to drive a car in the traffic autonomously, sophisticated computers developed knowledge through data analysis which enabled them to learn. However, it is still not possible to forecast how far the artificial intelligence development can go and how close to human brain it will become. Today intelligent machines control cognitive skills better than humans in many fields, while still do not show any “emotional intelligence”. The field of the research is on the practical economic applications of artificial intelligence such as robotics, autonomous vehicles, computer vision, natural language processing, logistic planning, financial forecasting, and machine learning.

The second part is the core of the research. In this section are analyzed the economic effects of artificial intelligence diffusion. The disruptive impact of new technologies is studied through the analysis of the traditional economic agents which are the firms, householders, and institutions. However, today the diffusion of the Internet is erasing these traditional distinctions since consumers can be also suppliers, multinational enterprises are always more similar to national institutions while the same concept of nation and border is vanishing. Anyway, the aim of this chapter is to explain in what way the AI revolution is already affecting the overall economy, in what dimension and, in particular, in which direction is going. Understanding these insights is crucial for companies that have to deal with new opportunities and threats, which will impact sectors

and business functions. In order to support the study, numerous concrete business cases and examples are exposed. In particular, the CMO and co-founder of the Italian startup Elaisian gave its contribution to this study providing his success story on AI business implementation. Elaisian is a bright example of artificial intelligence integration as core of the business model. This business case is provided in order to support the study with the concrete story of a successful start-up which took through the new technologies the opportunity to grow. In particular, this company utilizes artificial intelligence applications such as machine learning and predictive algorithms in the food tech industry.

Could new technologies cause mass unemployment? How will change the nature of work? These are the question this part is aimed to provide a solution. While technological automation does improve productivity, at the same time, it erodes human competences and increases pressure on workers. This trend is enhanced by soaring income inequality. In the end, what is the role of institutions and policy makers? Regulation and governments have a fundamental role in shaping the effects and the direction of the technological change. Institutions are called to redesign boundaries and incentives in order to alleviate biases and unlock the potential of such innovation. In this part are explained and analyzed the most incisive public policies and institutional intervention proposed in the last years.

In the final chapter of the work, is considered the global scenario of artificial intelligence diffusion. The stakes have the weight to completely redesign the global economic equilibrium. In this section is exposed how the multinational digital giants' competition for AI intertwines with government geopolitical aspirations. More than 70 percent of business leaders believe that AI will be the business advantage of the future.[1]
American digital multinationals strongly hold the AI supremacy all around the globe. The United States Silicon Valley is the most vibrant research ecosystem in the world, its pacific coast hosts the headquarters of companies such as Apple, Google, Amazon, Facebook which inject billions of dollars in R&D. Will this primate last forever?

[1] PwC, (2017).

According to the European Commission sources, the Asian countries are taking the lead of the AI wave.[2] China, Singapore, Japan, and South Korea have developed long-run strategies and allocated massive resources.

Chinese tech giants are investing more funds in AI internal research and in talent acquisition through an aggressive activity of mergers and acquisition all around the globe, supported by central government funds. At the same time, the Beijing government aims to become by 2030 the AI global leader considering such technology as the main factor for the economic growth and geopolitical power.

In the global race for AI supremacy, where does Europe stand? Who will win between China and the United State?

[2] EPSC Strategic Notes. (27 March 2018). "The Age of Artificial Intelligence". EU Commission.

I. Definition

"Just as the industrial revolution freed up a lot of humanity from physical drudgery. I think AI has the potential to free up Humanity from a lot of the mental drudgery."

Andrew Yan-Take Ng

I.1. General Definition

The first step is understanding what the general opinion, the scientist and the experts mean when they talk about Artificial Intelligence (AI). What is clear is that AI idea was born before its concrete realization and its later commercial exploitation in the last year. For what concerns the definition and the explanation of AI, there is no a homogeneous consensus about a punctual and shared definition because of its diversified and wide application. Today computers are able to drive cars autonomously, Blue Brain Project is able to mimic the neural networks of the human brain, Alpha Go can play games and beat a person, while scientists created technologies as Melomics or Aaron which compose music and create art.

The first person to use the term *Artificial Intelligence* was John McCarthy, known as the father of this science, in 1956 during the first academic conference on this topic: the Dartmouth Conference.[3] However, the first idea of AI appeared a decade before with Vannevar Bush which imagined a "system" able to amplify the individual knowledge and understanding.[4] In 1950 Alan Turing was the first to write about "Computing machinery" and "digital computers" able to imitate human beings, both in acting and in cognitive skills.[5]

Anyway, whatever the origin is, a general definition of AI may define it as a branch of science that seeks to "provide computers with cognitive skills, such as problem solving,

[3] Childs, M. (2011). John McCarthy: Computer scientist known as the father of AI. Independent. Haettu, 20, 2018.
[4] Bush, V. (1945). As We May Think By Vannevar Bush The Atlantic Monthly, July 1945. *Atlantic Monthly*.
[5] Machinery, C. (1950). Computing machinery and intelligence-AM Turing. *Mind*, *59*(236), 433.

decision making, reasoning, as well as voice, image, and language recognition, which are typically associated with human beings".[6]

According to Russel and Norvig, there are fundamentally four kinds of approaches to idea and definition of AI. They built a table in which definitions are placed along two dimensions: at the top horizontally are related with *thought* and *reasoning* processes, while at the bottom with *behavior*. Reading the table vertically, the left column refers to machine *human* performance of human-centered approach, instead, the right column is related with an ideal performance defined *rationality* made by a combination between mathematics and engineering.[7]

Table 1

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . machines with minds, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak & McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich & Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole 1998) "AI . . . is concerned with intelligent 13ehaviour in artefacts." (Nilsson, 1998)

Table of four AI definition draw by Russel and Nerving in 2003

[6] Kolbjørnsrud, V., Amico, R., & Thomas, R. J. (2017). Partnering with AI: how organizations can win over skeptical managers. *Strategy & Leadership*, *45*(1), 37-43.

[7] Russell, S. J., & Norvig, P. (2016). Artificial intelligence: a modern approach. Malaysia; Pearson Education Limited.

A machine or a program able to think humanly needs to have minds, this is called the cognitive approach and it is based on scientific theories about the functioning of the human brain. Cognitive Science is a different branch from AI.

The second human centered approach is about machines able to act humanly and its core application is the Turing Test approach, also known as "imitation game". According to this test, a computer is considered intelligent if a human interrogator, through only asking questions, is not able to notice that the answers are provided by a machine. If the computer is able to fool the human through its components of knowledge, reasoning, understanding, language and learning, so it is intelligent. Turing was the first to indicate the main fields of AI future application and anticipated the discussion about its threats and potentialities.

Different from the human oriented definition is the rationalistic approach. In such vision, AI is about a machine rational thinking based on the laws of thoughts through the codification of right thinking with logic. However, logical notes cannot express all thoughts or knowledge.[8]

In the end, computers may also be designed in order to act rationally, this is the theory of the rational agent approach. The artificial agent seeks to reach the selected goal, the output, autonomously through the optimal exploitation of its resources, the input.

Microsoft researchers consider AI as a "set of *technologies* that enable *computers* to perceive, learn, reason and assist in decision-making to solve problems in ways that are similar to what people do".[9]

If we focus on the term "*technology*" we refer to a software, an algorithm, a set of processes or a robot; many of these are extensions of pre-existing inventions while others are completely new creations. [10]

Key technologies have evolved towards 4 fundamental human cognitive skills:

1. **Sense**, today computers perceive the surrounding world through:

[8] Negnevitsky, M. (2005). *Artificial intelligence: a guide to intelligent systems*. Pearson Education.

[9] Microsoft Corporation, (2018). The Future Computed Artificial Intelligence and its role in society

[10] Purdy, M., & Daugherty, P. (2016). Why Artificial Intelligence Is the Future of Growth. Accenture.

    a. **Vision**: computers are able to recognize objects or faces in pictures or videos. In 2015 computers learned to such activity with the same precision of human eye.[11]
    b. **Speech**: computers are able to listen to vocal sounds, understand as words and transcribe them into texts. By 2017 has been developed a "speech recognition system" able to understand spoken words with the same efficiency of a team of professional transcribers.[12]
    c. **Language**: computers are able to understand the meaning of words, with their different shades of connotation and the complexity related to idiomatic or slang sentences.
2. **Knowledge**, computers analyze and understand information through the process of data they collect, they developed knowledge: the ability to understand the relationship between people, objects, places, events, times.
3. **Take action** in the physical world or within a process.
    a. **Inference engine or expert systems.**
    b. **Robotics and self-driving cars**.
4. **Learn** autonomously is the new human cognitive skill that computers are acquiring through experience in real world.

Referring to the academic world, professor Nils J. Nilsson, Stanford University, define artificial intelligence as "that activity devoted to making machines intelligent, and *intelligence* is that quality that enables an entity to function appropriately and with foresight in its environment".[13]

In this view humans, animals and some machines can be considered *intelligent* in many different "degrees".

According to Webster's dictionary, intelligence is "the ability to learn and solve problems".[14]

[11] Linn, A. (2015). Microsoft researchers win ImageNet computer vision challenge.
[12] Huang, X. (2017). Microsoft researchers achieve new conversational speech recognition milestone. *Microsoft, August*.
[13] Nilsson, N. J. (2009). *The quest for artificial intelligence*. Cambridge University Press.
[14] Webster's dictionary definition

In one extreme there are humans, with the highest "degree" of intelligence. Actually, humans are able to think, understand, learn, communicate, elaborate complex emotions and complex works or applications, process information, create artistic contents. Nilsson says humans "functioning appropriately and with foresight", humans have consciousness of the surrounding environment.

Thus, AI is about providing *machines* with *intelligence*, therefore, we have to define what a machine is. We can imagine it as a cold and complex arrangement of cables and mechanic system; however, nowadays the concept of machine is wider because of computers, systems composed of hardware and software. Still, this notion is becoming always more outdated because the newest computer systems are built with programs inside their own hardware actually.

By a different point of view, for what concerns *intelligence*, researchers argue that the actual status of AI has reached a good level of "Cognitive Intelligence" (IQ) while a weak grade of "Emotional Intelligence" (EQ). The former is related to the abilities such as "Visual and spatial processing, knowledge of the world, fluid reasoning, working memory and short-term memory, quantitative reasoning"; while the latter is the "ability to perceive, control, evaluate, and express emotions".[15] Today, as far as we know, machines provided with AI are able to perform IQ through processing data, learning information or, for example, playing chess, while they are still not able to express the empathy of EQ, maybe for the simple reason that machines cannot feel emotions. Is this the extreme border of AI evolution? It is not with the aim of this research answer to such question, even if an answer may still exist.

Therefore, how far we can go? Talking about extreme borders and future implications, there is still another distinction that has to be made referring to AI: the concept of "narrow-AI" (weak AI), performing to limited specific task, in opposition to the concept of "artificial general intelligence" AGI (Strong AI), a computer able to perform the totality of human intellectual task, a fully autonomous entity.[16] It may seem really a

[15] Abdul, L. A., & Ehiobuche, C. (2011). Emotional Intelligence and Managerial Competence. *Insights to a Changing World Journal*, (4).

[16] Chui, M., & Francisco, S. (2017). Artificial intelligence the next digital frontier? *McKinsey and Company Global Institute*, *47*.

futuristic achievement but there are already companies working on it such as OpenAI.[17]

"Most AI researchers take the weak AI hypothesis for granted, and don't care about the strong AI hypothesis—as long as their program works, they don't care whether you call it a simulation of intelligence or real intelligence. All AI researchers should be concerned with the ethical implications of their work".[18]

I.2. Application

Whether if we notice or not, Artificial Intelligence is already present in our life. Computers track our habits, keep track on our preferences, our tastes, interests, relationships. Fields of AI application are expanding every day fed by huge amount of data we leave around digested by complex algorithms. Considering the future evolution of this technology, the analysis examines its practical application to the solution of concrete business problems.

However, this research is focused on the business application of AI related to narrow-task uses. Analyzing the investment flow of the last years, four main direction of AI application emerge:

1. **Robotics and autonomous vehicles**. Nowadays self-driving cars are tested by Tesla, Google, and Waymo while robotics is making important improvements in the last decade. Robots as NAO and ASIMO can actually dance, but there are large practical applications such as surgery or household keeping. For example, Mazor Robotics, a company that implement robotic guidance systems for spine and brain surgeries. A test demonstrates the decrease of risks of compliances and 78% decrease in exposure to radiation with robotic surgery.[19]
2. **Computer vision** based on processing information from the external world in order to "make useful decisions about real physical objects and scenes based on

[17] "About OpenAI", OpenAI website.
[18] Russell, S. J., & Norvig, P. (2016). Artificial intelligence: a modern approach. Malaysia; Pearson Education Limited.
[19] Kite, Powell, (2018).

images".[20] A widely used technology is the face detection through the so called Viola–Jones object detection framework algorithm.[21] At the same time, computers are now able to recognize handwritten messages. Significant progresses have been made in medical application of computer vision. Computers can detect the presence of breast cancer watching mammography images.

3. **Natural Language Processing (NPL)** which studies the interaction between the human language and computers.
4. **Virtual agents,** autonomous entities which observe through sensors, acts upon an environment and directs its activity towards achieving goals[22]. The implementation of speech recognition and natural language understanding is driving the development of virtual agents such as Apple Siri, Amazon Echo, Google Now, Microsoft Cortana. Agents helps humans in their everyday practical tasks. The aim is to design the best agent in order to achieve the best possible performance, given some limitations.
5. **Machine learning,** the new frontier based on the human skill of learning on experiences and data. Machine learning is about the creation of a computer program that improve with experience based on observation of data.[23]

However, there are also many other fields of AI application such as social network analysis, route finding, document summarization, logistic planning, financial forecasting. This list seeks to group in 4 main general areas.

Furthermore, in relation to each application, it is necessary to understand the aim of AI. Thus, if there is the purpose of substitute or assist the human in his jobs and tasks. Studying the topic in relation to the human involvement, the science is developing four forms of AI with:

1. **Human involved**:
    a. *Assisted Intelligence*: AI systems assist humans in making decisions or

[20] Shapiro, L., & Stockman, G. C. (2001).
[21] Viola, P., & Jones, M. (2001, July). Robust real-time face detection. In *null* (p. 747). IEEE.
[22] Russell, Stuart J.; Norvig, Peter (2003).
[23] Tom Mitchell

taking actions. Hard-wired systems that do not learn from their interactions.[24]

b. *Augmented intelligence*: AI systems that augment human decision making and continuously learn from their interactions with humans and the environment.[25]

2. **No Human involved:**
   a. *Automation*: Automation of manual and cognitive tasks that are either routine or non-routine. This does not involve new ways of doing things – it automates existing tasks.[26]

   b. *Autonomous Intelligence*: AI systems that can adapt to different situations and can act autonomously without human assistance.[27]

It is about the Autonomous Intelligence that worries are surging because it is non controllable by humans for its definition. "By definition a fully autonomous system is one that we have no control over," Dietterich said. "And I don't think we ever want to be in that situation."[28]

I.3. Why Now?

We said Artificial Intelligence idea was not born in the last decade but it comes from the last years of the second world war. In these years the definition of AI did not exist yet, but scientists were working on the implementation of neurons that were artificial. The names of these scientists were Warren McCulloch and Walter Pitts, the year was the 1943 and that system of connected artificial neurons was the first example of artificial

[24] Rao, A. (2017). A Strategist's Guide to Artificial Intelligence. *Strategy+ Business*.
[25] Industry-Specific Augmented Intelligence: A Catalyst For AI In The Enterprise, Ganesh Padmanabhan, Forbes, JAN 4, 2018
[26] PWC, (2018).
[27] PWC, (2018).
[28] Here's the real reason artificial intelligence could be a threat, Cadie Thompson, Tech Insider, Sep. 17, 2015

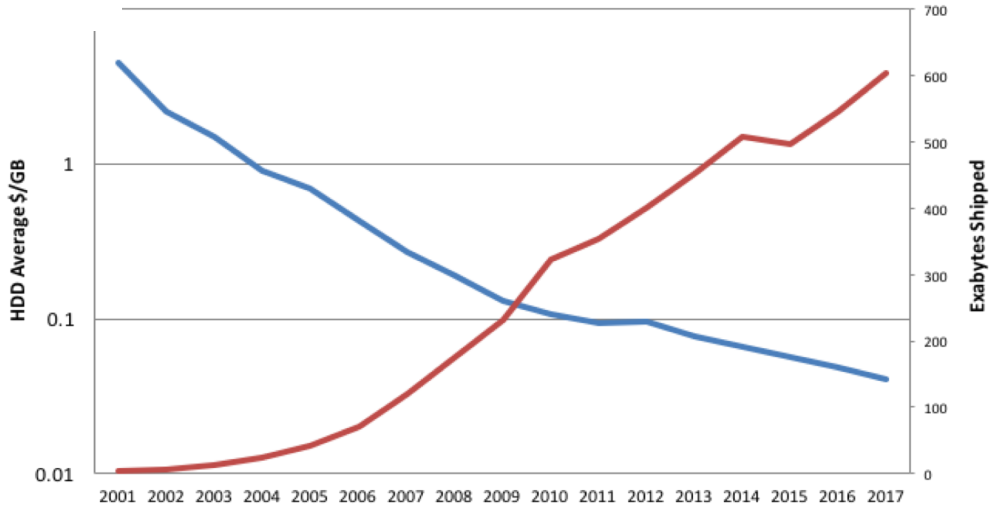
intelligence. Based on the knowledge of human brain neurons applied to the Turing's theory of computation they created an automatic model of computer response to external stimuluses. As we said before, the definition of AI was coined by John McCarthy about 10 years later.

The years of '50 and '70 were characterized by great enthusiasm, expectations and by the implementation of the first AI applications such as the Samuel's checkers program.[29]

After decades of research and development, it is clear that in particular today the progress and the importance of AI is flourishing. This is related to the evolution of three key factors:

1. the expanded availability of **data**;
2. increasing of **cloud computing power**;
3. more powerful **algorithms**;[30]
4. decreasing **storage cost**, from around $500,000 per gigabyte in 1981 to less than $0.03 per gigabyte today.[31]

Figure 1



Coughlin Associates Data[32]

[29] Schaeffer, J. (2006).
[30] Microsoft Corporation, (2018).
[31] Andy Klein. (July 2017).
[32] HDD refers to Hard Disk Drive Storage; 1 exabyte is about 1 trillion of byte or 1 millions of terabyte, 1 terabyte is 1000 GB

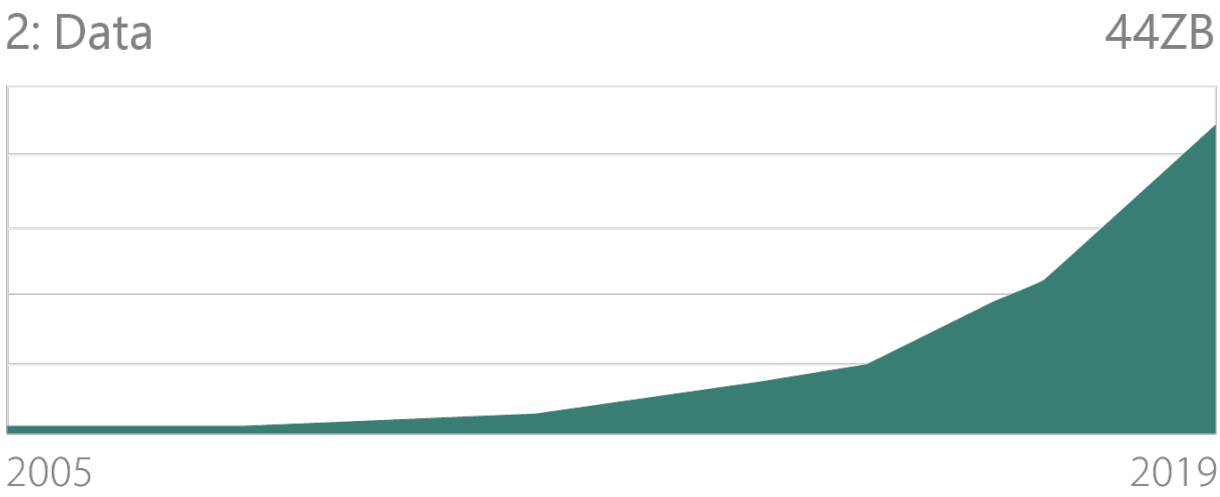


Figure 2

Source: IDC Digital Universe Forecast, 2014

Our lives are always more digitalized; people nowadays spend an average of 27 hours per week online, sensors are cheaper and diffused, almost everything we do leave tracks in the form of data.[33] The table below shows the data availability forecast for 2019, growing at exponential rate.

According to the latest analysis, the value of the European data economy may rise to €739 billion by 2020, representing 4% of the overall EU GDP.[34] Data are generally considered the new oil; they are the fuel that provides power to computers and algorithms, the engines of the modern economy. At the same time, as well as oil, data have value only when mined and refined, because data itself has no value as long as it is not elaborated. Oil scarcity creates its value, while value of data increases with the insights generated by combinations of data sets and analytics.[35]

There are no costs of transportation of data while extraction is becoming always cheaper considering that they can be reused multiple times for multiple purposes.[36]

However, just like oil, there are different kind of data which is not valuable in the same way but its quality has a fundamental impact on the enterprise strategy. It is essential

[33] Elizabeth Anderson. "Teenagers spend 27 hours a week online: how internet use has ballooned in the last decade". *The Telegraph.* 11 May 2015.
[34] Digital Single Market Stretegy. "Building a European data economy", European Commission, April 2018.
[35] Muqbil Ahmar.
[36] Sapan Talwar, CEO, Aristi Ninja

knowing which data to use and how with respect to the specific company, in the same way we chose oil for the specific car. “You make the mistake of choosing wrong data and your business shuts down like an engine.”[37]

Still using this common analogism, as well as oil produces negative externalities and its exploitation rises environmental issues, also the extraction and the employment of data creates privacy controversies and biases.

However, analyzing such a huge amount of data requires a massive computing power that only today is developed enough to manage this continuous flow thanks of the new cloud computing technologies. Indeed, today computers do not need large size machines and energetic requirements. Algorithms plays a crucial role in this process. They are the stomachs able to digest the information and re-elaborate them. Through algorithms computers learn, understand people behavior and preferences, make forecasts, suggest products, trade financial services on the stock market, affect the hiring processes of big companies. Their impact on society is discussed because they learn from data, thus data quality influence the outcomes produced. Algorithms can enhance negative bias. This is the case, for example, of Tay chatbox launched on Twitter. The more you chat with Tay, said Microsoft, the smarter it gets, learning to engage people through "casual and playful conversation”.[38] The problem was that Tay became in less than 24 hours became racist because it *learned* from interacting with users on twitter.[39]

[37] Alok Singh, Head Operations Marketing & e-commerce at Ultra Media & Entertainment Pvt. Ltd.
[38] Vincent, J. March 2016. Twitter taught Microsoft’s AI chatbot to be a racist asshole in less than a day”. *The Verge.*
[39] Rordiguez, A. March 2016. “Microsoft’s AI millennial chatbot became a racist jerk after less than a day on Twitter”, Quartz.

II. Economics of Artificial Intelligence

Technological progress has always been one of the main drivers of economic growth. Innovation applied to the economy produce increases in productivity and efficiency. This means that companies can produce more with fewer energies, with less working hours and lower costs. Increased productivity usually translates into higher wages and better living standards.

Artificial intelligence is the new driver of technological progress. The acceleration of artificial intelligence innovation will enable the automation of many tasks previously only related to human labor.[40]

This revolution will create new opportunities and generate a completely new kind of occupations and jobs. The economic potential is massive but, at the same time, it has the power to disrupt the life of billions of people and unsettle the concept of capitalism itself.

The effects of Artificial intelligence disruption do not only depend on the technology itself but, the outcomes depend on the reactiveness of enterprises and the policy responses authorities and institutions are able to offer. Meanwhile, all the economic benefits deriving from the technological progress have been unequally distributed fostering inequality. The gap between the 1 percent of people holding half of the global resources and the rest of 99 percent is still expanding as never in the modern history. This trend is enhanced by the slowdown of improvement in the level of education, the decline of minimum wage and the inadequacy of policy responses.

At the same time, Artificial intelligence is investing transversally all industries and impose companies to rapidly readapt to the new deal. Evidence shows that AI constitutes a strategic competitive advantage reflexing on growing revenues of the earlier adopter firms. Those firms are tech giants of which the stock value is skyrocketing as Apple, Google, Facebook, Amazon and many more. They still hold the majority of investments

[40] The White House, October 2016. Preparing for the Future of Artificial Intelligence

flows in this direction while through campaigns of mergers and acquisitions are absorbing smaller firms and startups.

In this fast-paced growing environment, institutions are called to redesign boundaries and incentives in order to alleviate biases and unlock the potential of such innovation. AI-driven innovation will continue to create wealth and foster the economic growth. New technologies will increase the quality of our lives but, this growth is not painless and it is disruptive. It requires profound transformations in the nature of work and the organization of our society. With the implementation of new technologies, new skills are needed for workers and new strategies are indispensable. Institutions are required to intervene in order to help those workers that will be disadvantaged and displaced by such changes in order to ensure that the enormous benefits created by AI are accessible to everyone and developed in the best way.

In this chapter is shown the analysis of Artificial intelligence impact on the overall economy referring to the 3 main actors:

1. Householders;
2. Firms;
3. Institutions and policymakers.

For what concerns the state of debate there is no a homogeneous consensus about the direction, time, and impact that AI will have. Nowadays, scholars, technologists, economists are divided, there are divergent analysis and dissimilar timeframe focus. The issue is that is hard to predict exactly the AI trend because it is not a single technology but, rather a collection of technologies and the effects will impact unequally the economy.[41]
Furthermore, the AI revolution has tremendous speed growth while it still more complex forecast chain reaction for consequents innovations: cluster innovation.[42]

[41] Executive Office of the President (EOP), December 20, 2016 "Artificial Intelligence, Automation, And The Economy"
[42] CFRr. B. Keirstead, *The Theory of Economic Change*, MacMillan, Toronto, 1948.

The digital revolution is growing at an exponential rate. Gordon Moore, in 1965, observing the speed to which transistor computer power was growing, predicted an emerging trend.[43] This prediction is known as Moore's law, it is the most famous measure for tracking advancing computer power and, today it is the pace for our modern digital revolution.

As the innovation in the production of transistors continues to develop, more capability can be stored in always more limited space and, therefore, the cost is constantly declining. In the only year, 2014 have been created more transistors than in all the years before 2011. Moore's law is also important by an economic point of view because once proven, manufacturers can plan better ahead investments.[44]

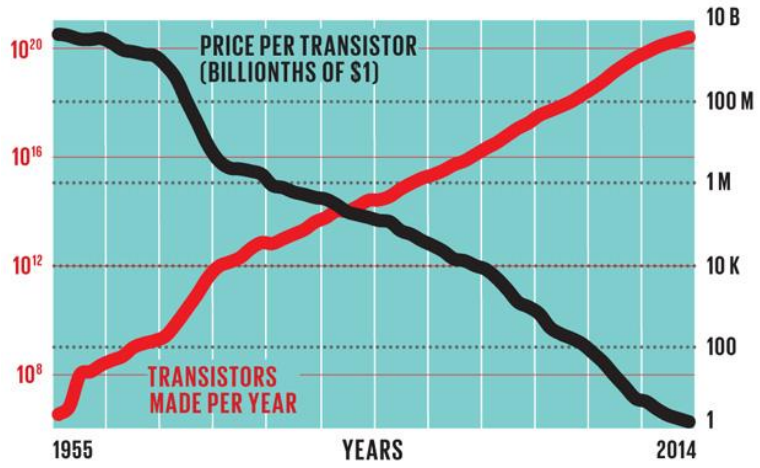


Figure 3

Data Source: VLSI Research

Industrial revolutions had an incremental growth rate. However, pursuing this direction, in the 2020s the size of one transistor may reach the space of about 5 nanometers (billionths of a meter), and it may be the physic limit beyond is no more possible any miniaturization.[45]

Even if the computer hardware evolution is going to decline, the IT revolution is not going to stop for the reason why it places in the intersection between the realm of atoms, the limited world governed by the laws of physic, and the realms the "new atom": the bit.

[43] Intel, 2015. 50 Years of Moore's Law,
[44] Hutcheson Dan, 2015.
[45] "With 3D Chips, Samsung Leaves Moore's Law Behind", Michael Kanellos, Aug 14 2013, Forbes

The bit kingdom is an abstract territory ruled by algorithms and mathematics; there are no atomics restrictions that can halt the progress.

Artificial intelligence cast the economy into a transformation stage between a traditional economic structure and the new economic paradigm. The structure of capitalism itself may be challenged towards the evolution or the expiration. Nowadays, the diffusion of the Internet is blurring away differences between the traditional economic agents: consumers can be also producers, firms start to play the same role as national institutions while the same concept of nation, the border is vanishing.
However, while Moore's law is setting a long-term growth model, if we analyze the short-term, the progress is way more complex and irregular.[46] Short-term trend is not constant: it is affected by an explosion or pauses and it unevenly impacts industries.

The aim of this chapter is to explain in what way the AI revolution is already affecting the overall economy, in what dimension and, in particular, in which direction is evolving.

II.1. Artificial Intelligence and Enterprises

In this section, the effects and implications that artificial intelligence-driven innovation has on firms and businesses are exposed. AI has experienced huge advancements in these years while, though, its adoption by the firms is still small.
However, there is evidence that AI constitutes a strategic competitive advantage reflexing on the growing revenues of the earlier adopter firms. Those firms are tech giants of which the stock value is skyrocketing as Apple, Google, Facebook, Amazon and many more.
The amount of their investments in AI research is extremely high and it evidences the extent of this innovation. Digital native companies like Baidu, Google or Facebook, for example, constitute the most advanced lines of the so-called "digital frontier" with

[46] Ford, M. R. (2015). Rise of the robots technology and the threat of a jobless future. New York, NY: Basic Books.

investments that state around $20-30 billion only in 2016, while, in the last years, also venture capital funds are starting to invest more; numbers say more with that $4 billion of investments and more than $1 billion from equity funds.[47] The level of the attention for AI is growing, however, the vast majority of economic efforts in this direction are still internal investments from tech giants.

This is a limiting factor because all R&D energies are directed to the implementation of the firm-specific necessities restricting the extent of AI application for other business fields, while a concrete demand from the market for such technology is still low.

The current situation is in the early stage. Many efforts have been made mostly by the biggest technology suppliers while for most of the companies AI is still in the development stage. There are not numerous products available on the market and adoption is for now limited. For this reason, experts are still divided about the real extent of AI innovative revolution, especially by an economic viability point of view. The proof of that is the high variance of investments detected on the market: few big investors while the vast majority seems not yet involved.[48]

Moreover, measuring the level of AI development is hard though, first, because there is no a shared consensus on the definition of AI and the boundaries of its application; second, because it is complicated to define AI products since many are completely new ones while others are extensions of already existing ones.

Only the big players are leading the direction of AI development. Giants in the car manufacturing industry are focused on AI implementation for driverless cars, robotics, and machine learning. Amazon is investing in speech recognition, and sales algorithms while Google and Apple are not focused on specific fields but are working on a broader scale. ABB, Bosch, GE are implementing machine learning only for firm-specific necessities.[49]

According to a McKinsey survey on 3073 firms, only the 20 percent of them declared to have adopted AI related technologies while on 160 business cases only the 12 percent have advanced over the experimental phase.[50] Companies indicated the poorness and the

[47] Mckinsey Global Institute, (June 2017).
[48] Mckinsey Global Institute, (June 2017).
[49] Trudell C. Hagiwara Y. (November 6, 2015). Toyota starts $1 billion center to develop cars that don't crash. Bloomberg.
[50] McKinsey Global Institute, (March 2017).

uncertainty of returns in front of high investments required as the main cause of their hesitancy.

AI adoption is happening mainly in the high digitized sectors as High-Tech and telecommunications, followed by automotive and assembly industries, financial services, resources, utilities, and media.[51]

Firms operating in these sectors are also those ones that were already investing in big data and cloud services, the main ingredients of AI. The less adoptive sectors are education and healthcare where regulatory barriers and customers' acceptance may inhibit AI implementation.[52]

Moreover, it seems that the scale of the company influences the degree of AI adoption since they are able to exploit successfully scale economies and leverage big volumes of investments. Furthermore, larger firms have access to the wider range and better quality of data, have more qualified employees.

Beyond the adoption, tech giants are draining competences and skills by absorbing all small startups through a process of M&A, called "acqui-hiring". This causes a lack of independent AI experts on the market and it raises their price. M&A is the main way tech giants use to fund and seize AI research. According to data, Google is the most active company in this "market", followed by Apple.

Amazon is achieving important results with the acquisition of the robotics firm Kiva at the price of $775 million. Data show the increase of inventory capacity by the 50 percent, the fall in cost by 20 percent and a return on the investment of 40 percent.[53]

At the same time, tech giants scout talents. Facebook opened some AI lab in Europe, Intel funded a research center at Georgia Tech while NVIDIA is scouting through the University of Taipei.[54] Only in the last years, external investments as private funds, venture capitalist and incubators entered in the AI development market in the rush for the leadership of the new technologic innovation. Esteems count a business of around $10

[51] McKinsey Global Institute, (December 2015).
[52] McKinsey Global Institute, (December 2015).
[53] Kim E. (June 15, 2016). Amazon's $775 million deal for robotics company Kiva is starting to look really smart. Business Insider.
[54] "Georgia Tech launches new research on the security of machine-learning systems," Georgia Institute of Technology press release, October 31, 2016;
"NVIDIA collaborates with Taipei Tech to establish Embedded GPU Joint Lab," National Taipei University of Technology press release, September 4, 2014.
Cade Metz, "Facebook opens a Paris lab as AI research goes global," Wired.com, June 2, 2015.

billion only in 2016.[55] For what concerns the direction of these financing flows, machine learning technology is the one that accounts for the most investments because considered as "enabler" of other consequent inventions.[56]

The main fields of AI research are:

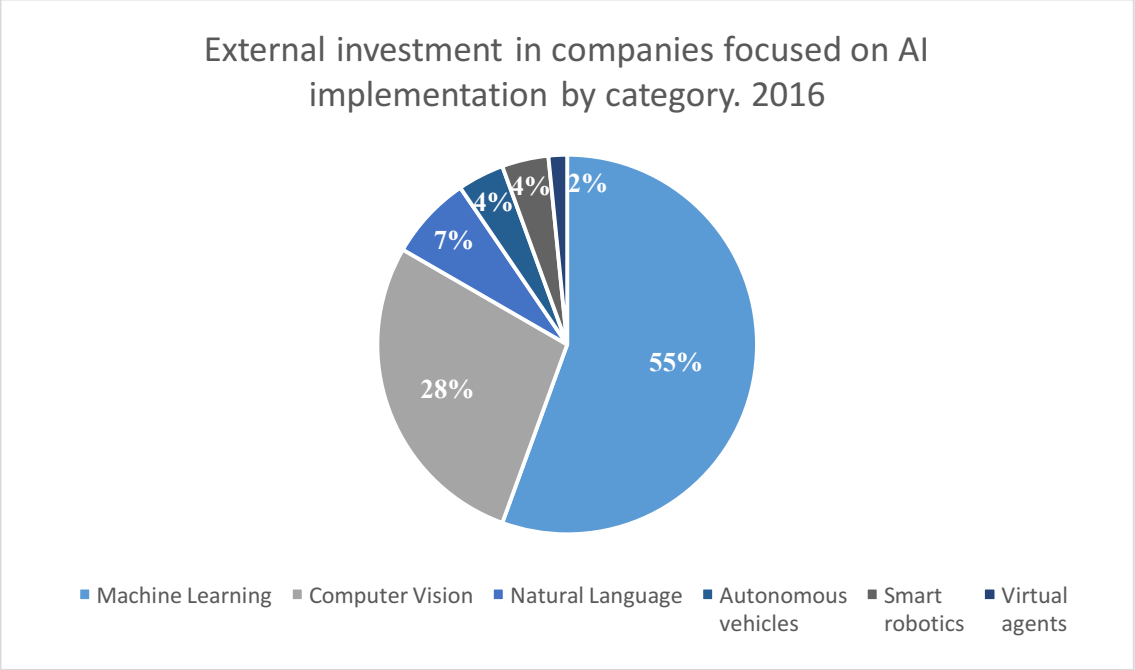


Figure 4

Data from Dealogic databases, 2016.

However, external investments in AI from 2013 to 2016 growing by 40 percent but, at the same time, the risk is still high since only the 10 percent of start-ups that have machine learning as core business does generate profits.[57] Investors are waiting for results to come while, for now, the majority of AI external investments are concentrated in few technology hubs in the USA and China.[58] Europe is still far away in this run and the gap with other international powers is expanding.

[55] Goldman Sachs estimates that the venture capital sector alone made $13.7 billion of AI-related investment that year.
[56] McKinsey Global Institute, (January 2017).
[57] PitchBook database 2016.
[58] Mckinsey Global Institute, (June 2017).

Evidence suggests that the implementation of AI technology inside the core business leads to an impressive result. This is true especially for those companies that implemented AI as part of their core business. For example, Netflix uses AI algorithms to adapt to movie recommendations to the specific user's tastes. It means that the time spent on selecting a TV show or movie is lower than 90 seconds, the give up level. This has improved the search result which has reflected into a higher customer retention rate; an important result since there are actually more than 100 millions of subscribers, and the outcome is worth $1 billion per year.[59] This is the same for Amazon that, with a similar approach to the product suggestion designed on personalized customers tastes, has drastically reduced the "click to ship" time reducing costs drastically.[60]

Furthermore, evidence shows that the degree of strategy proactivity and AI involvement have a strong influence on the profit margins of companies. According to the previous McKinsey survey those companies that declared the aim of disrupting the industry through AI as a core business or have shaped the long-run strategy around the AI implementation, experience significant results.[61] These outcomes are divergent for those companies that are partial adopters or are only dealing with AI in an experimental stage.

[59] McAlone N. (June 14, 2016). Why Netflix thinks its personalized recommendation engine is worth $1 billion per year. Business Insider.

[60] Kim E. (June 15, 2016). Amazon's $775 million deal for robotics company Kiva is starting to look really smart. Business Insider.

[61] Mckinsey Global Institute, (June 2017).

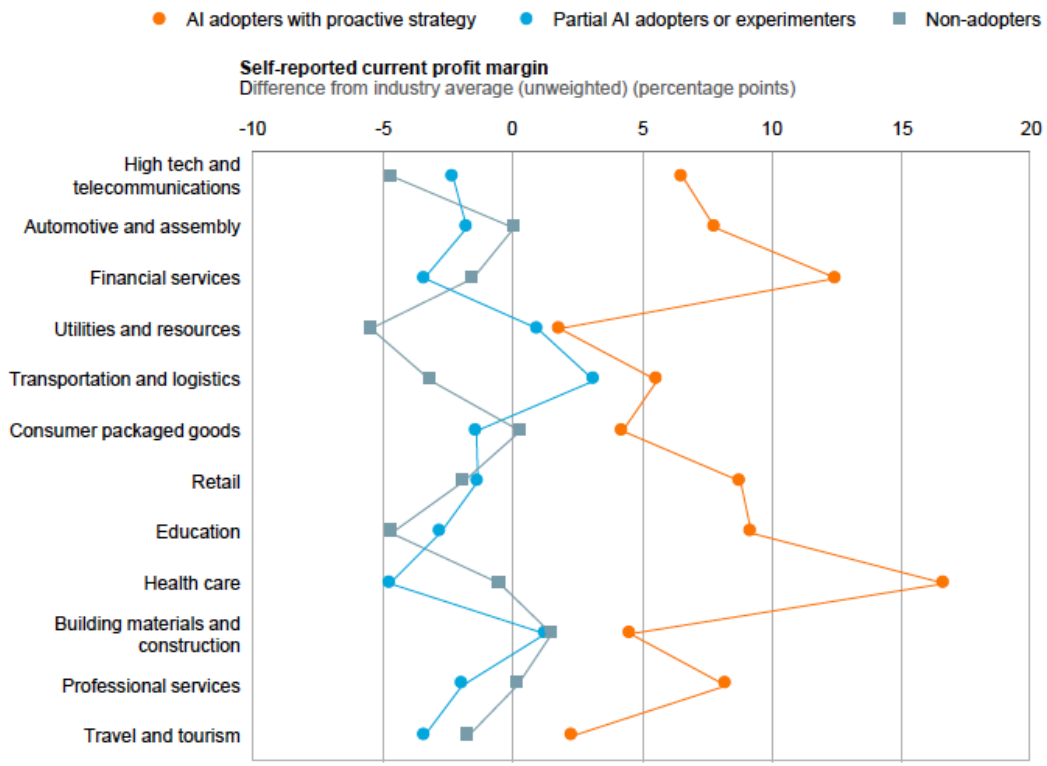


Figure 5

Data: McKinsey Global Institute AI adoption and use survey, McKinsey Global Institute analysis.

II. 1. A. Artificial Intelligence Business Application

In order to go into a deeper analysis of the effects that the implementation of AI has on specific business areas and activities. In the examples provided in this section, there are demonstrations of how concretely this new technology is affecting revenues, reducing costs and creating value. These are the main areas where AI is applied:

- **Projection and forecasting** in order to and analyze demand trends, optimize supply;
- **Produce** better goods and services reducing cost and enhancing quality;
- **Promote** products with the right messages to the targeted customer at the best price;
- **Provide** more personalized user experiences.

Projection and forecasting

AI has a crucial role in projecting and forecasting trends and patterns from the analysis of vast flows of data. Sophisticated algorithms extract information and are able to recognize paths and trends in the behavior of demand. The knowledge of future movements is a powerful competitive advantage because has a huge impact on costs and the enhancement of assets. Predicting the future behavior of customers is crucial in shaping marketing strategies, anticipate sale trends and better manage the supply chain. In the specific, the main benefits of AI-based approaches impact the **supply chain** management, **research, and development** operations and the business **support functions**.

In the business process, AI-enhanced **supply chain** management increases the precision of forecasts and optimize asset utilization.[62] The efficiency of the supply chain is crucial for the success of a company and, the key strategy to achieve a competitive advantage is realizing the perfect combination of demand prediction and inventory replenishment strategies. However, nevertheless it is quite impossible to make the supply chain works at the perfect level of efficiency due to its high complexity, companies are realizing AI enhanced approaches in order to reach flexibility and avoid bullwhip situations.[63]
In particular, machine learning technology is a key tool in order to power supply chain optimization.
Reinforcement learning systems are the most advanced implementation of AI for inventory management. They allow machines not only to produce forecasts but, to directly act on them without human intervention. Demand fluctuations are projected with precision while routes and volumes of materials are automatically adjusted by the algorithms; results show a decrease of 32 percent of operative costs.[64] Lost sales related to unavailability of products experienced a reduction up to the 65 percent while inventories are susceptible of from 20 to 50 percent of reduction.[65]

[62] McKinsey & Company, (April 2017).
[63] Mckinsey Global Institute, (June 2017).
[64] McKinsey & Company, (April 2017).
[65] Hamilton, Alasdair. (July 2018). Artificial Intelligence for Inventory Management". Medium.

An ai-based approach is crucial in the retail business; it allows to reduce forecasting errors on demand by the 30-50 percent while transportation, warehousing, and administration costs tend to fall up to 40 percent.[66]

The match between supply and demand is particularly important in the industry of electric utilities. In this field, the real-time alignment between electricity supply loading and demand can produce significant effects on energy savings and emissions.[67] Forecasting the demand fluctuation is crucial.

This is what happens in the agreement between the UK's National Grid and Google's Deepmind. The objective is employing AI, in particular, machine learning technology, for the balance of supply and demand. Algorithms can predict more accurately the behavior of demand and help to regulate supply more efficiently.[68] According to DeepMind's CEO, machine learning applications are able to "save 10 percent of the country's energy usage without any new infrastructure, just from optimization".[69]

The same optimization that has been already achieved in the Google's data center where the amount of energy used to freezing computers dropped by the 40 percent.[70]

Employment of AI for forecasting demand is what Otto, a German online retailer, did. Here AI is not only implemented to analyze data and customers tastes, but computers automatically take decisions and purchase around 200,000 articles every month from third-party companies without human intervention.[71] Its deep-learning algorithms analyze something like over 200 variables to predict what consumers are going to buy a week before the order. Incredibly precise and reliable, Otto's algorithms reach a precision of 90 percent on customers' sales prediction.[72]

Artificial Intelligence is also a powerful tool for **R&D functions** since it used to anticipate the success of developing projects. The management of different research and development projects usually raise issues related to technical and market uncertainties

[66] McKinsey & Company, April 2017.
[67] Murgia M. and Thomas N. (March 12, 2017). DeepMind and National Grid in AI talks to balance energy supply. the Financial Times.
[68] Murgia M. and Thomas N. (March 12, 2017).
[69] Npower, (January, 2018). AI: fuelling a revolution in energy management,
[70] Npower, (February , 2017). Energy management systems that can think for themselves.
[71] How Germany's Otto uses artificial intelligence. The Economist, April 2017
[72] AI in Retail: See How Otto Embraced Innovation. Blue Yonder January, 2018.

that have to face budget and time constraints. Complexity is amplified by communication complications between different competencies inside the company. For the management, it is hard to select the most promising projects since the long-term nature and the difficulties in measuring progress.[73] AI-based approaches in the R&D field produce significant effects on the project performances while raising the efficiency of budget spending. Quantum-Black is a company which utilizes AI-based approach for data analysis in order to assist and empower the R&D process. AI streamline the R&D activity, analyzes different data from diversified sources and forecasts performances detractors.[74] Such an AI approach is implemented in F1 to measure the pit stops' performances. Pit stop strategy is the key to the victory in races. Sensors and cameras are placed in order to catch real-time data and process them with complex algorithms. Results show the accuracy target for image processing phase has declined to less than 1 millisecond, which can have a significant impact on the race.[75] In other application data show that AI such approach has increased the R&D performance by 10-15 percent, 10 percent less is the time to market with a significant decrease in risk.[76] Features particularly interesting also for the pharmaceutical research where are invested every year around $160 billion only in the United States.[77]

Production

AI enhances the performance of assets, optimize the process of transformation of input into output while ensuring reliability and quality; all this means enhanced productivity. There are many examples of AI-based robot implementation in the production process.

The online chain of supermarkets, Ocado, has developed an army of robots run by AI algorithms and deep learning application. In its warehouse, there are hundreds of robots that work collaborating with humans. When the customer selects the products, robots steer them to human packers. They consign the package to other robots that dispose them

[73] McKinsey & Company, April 2017.
[74] McKinsey & Company, April 2017.
[75] Quantum-Black, Timing systems, F1 business case.
[76] McKinsey & Company, April 2017.
[77] "Artificial Intelligence the Next Digital Frontier?", Mckinsey, Discussion Paper June 2017

into vans according to the consumer's house destination. These robots are able to collaborate with humans handling on average 50 items in only 1 minute.[78] Ocado developed a perfect human-robotic work chain thanks to innovations in computer vision and advanced AI which allows robots to interact autonomously with the real world and humans. Paul Clarke, Chief Technology Officer, Ocado declared that "working alongside AI, we have the ability to generate insights and make discoveries that are beyond our human minds."[79]

The convergence between human and AI automation is a powerful tool. Especially if such convergence is directed towards the speedup of production process performance while at the same time enhance quality and reduce errors. In particular, for manufacturing industries, it is central to the issue of yield losses which occur when products have to be disposed of or reworked because of defects.[80] For example, semiconductors manufacturers experience up to 30 percent of total production cost only for testing and yield losses of their goods.[81] AI-powered engines are being implemented in the last years in order to individuate yield losses causes and avoid them through the production process redesign.

The vast amount of data from sensors and databases are ingested by machine learning applications which are today able to estimate the useful life of devices and detect right the time of decommissioning. Traditionally, the expiration time of an asset is estimated but, with AI application, enterprises are able to individuate the precise moment of its dismissing. This is what happens for power distribution which implemented AI to extract the highest value from their assets. In particular, this is the case of the maintenance of electrical grids. The traditional maintenance process determines a regular schedule of inspections in order to ensure asset to always work properly. Implementing AI in this field allows the employing of the condition-based maintenance system.

[78] Clarke P. (May 15, 2018). Ocado Is Transforming Online Grocery Shopping with AI, But A Skills Challenge Lies Ahead. Harvard Business Review
[79] Clarke P. (May 15, 2018).
[80] McKinsey & Company, April 2017.
[81] McKinsey & Company, March 2017.

In practice, what happens is that AI runs remote inspections, more frequently and more accurately, reducing costs up to 30 percent.

What if the same maintenance process is applied to humans? The positive effects of AI technology go far behind the economic profit and it could provide benefits also for human health. With the same process of power grid control, doctors could inspect and check the health status of the patient remotely and constantly while algorithms and AI engines would analyze personalized medical data in order to forecast emerging diseases.
All this taking into account the medical situation of the patient integrated with environmental factors which have effects on health such as pollution. Google Cloud is one of the big players in the healthcare industry. Evolution in AI computer vision technology-enabled computers to diagnose diabetic retinopathy, the fastest growing cause of blindness in the world.[82] Timing is crucial to determine the success of any medical treatment, if treated too late the blindness is irreversible. There are only a few specialists able to detect the diabetic eye. Google Cloud built an algorithm based on deep machine learning able to recognize retinopathy disease through evaluation of photography.[83] The algorithm performed a score of 0.95 out of a scale of 1.00 while ophthalmologists achieved 0.91.[84] This means that AI deep learning algorithms perform better results than human specialists.[85]

Promotion

Airline seat price is adjusted dynamically in relation to the time of the day, season and many other factors. This same mechanism regulates the fluctuations in the price of hotel rooms online or the price of ticket trains. It is called yield management mechanism: AI-

[82] GoogleAI: Healthcare and biosciences: https://ai.google/research/teams/brain/healthcare-biosciences
[83] Journal of the American Medical Association, November 29, 2016. Development and Validation of a Deep Learning Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus Photographs,
[84] Lily Peng and Varun Gulshan, November 29, 2016. Deep Learning for Detection of Diabetic Eye Disease", Google AI blog.
[85] The results show that AI algorithm's performance is on-par with that of ophthalmologists. On the validation set described the algorithm has a score (combined sensitivity and specificity metric, with max=1) of 0.95, which is slightly better than the median F-score of the 8 ophthalmologists consulted (measured at 0.91).

powered algorithms analyze the vast amount of data in order to set the right price for the specific customer. AI is employed to regulate prices, personalized marketing campaigns creating the right message for the right target. This mechanism is based on the estimation of the price that the customer is willing to pay. AI determines the price elasticity for every product and automatically correct prices according to the target product strategy.[86]

In the retail industry AI select the size of discount and personalizes promotion in relation to information on the customer such as age, gender, habits and much more. AI enhance the precision of the offer and its efficacy because algorithms know what the shoppers want before the shopper themselves. Researchers found out that Facebook algorithms analyzing only 70 likes knows you better than a roommate, with 150 more than a parent, 300 likes it knows more than your partner.[87] This means that the level of accuracy of the AI-powered tool is extremely efficient. Implemented online such strategies led to a 30 percent growth in sales.[88] Algorithms learn and identify patterns from huge volumes of data from many different sources, like social media, online transactions, facial expressions analysis, online browsing history.[89] The final step is the automation of suppling negotiations based on anticipated customers' expectations.[90]

Carrefour and Target have installed in-store sensors to gather data on customers' behavior and purchasing habits in order to employ AI learning algorithms for developing personalized offers and promotion.[91] Data are a precious resource from which extract useful information and improve strategies. The results show an increase of 600 percent in app users after the installation of sensors in 28 stores only.[92]
In this field, AI facial recognition could identify faces of frequent customers in the store and give them advice or personalized offers, based on learning machine technology applied to the history of their sales. The online fashion personal-shopper Stitch Fix goes

[86] Mckinsey, June 2017.
[87] Quenqua D. (Jan 2015). Facebook Knows You Better Than Anyone Else. The New York Times
[88] Mckinsey, June 2017
[89] Feldman B. (January 17, 2018). What Today's Shoppers Want, and How Omnichannel Retailers Can Satisfy Them. MarketingProfs.
[90] McKinsey & Company, April 2017.
[91] Mittal S. (February 11, 2016). 25 retailers nailing it with their proximity marketing campaigns. Beaconstac.
[92] Mittal S. (February, 2016).

further by creating an algorithm that studies consumers' behavior through their Pinterest activity online. The service is able to understand people preferences, their personal style, and needs by analyzing their social media conduct.
Thus, Stitch Fix has integrated the expertise of stylists with the insight and efficacy of artificial intelligence to process data on fashion trends, body sizes, customer preferences, and opinion to deliver the human stylists regularly scheduled recommendations.[93] In 2017 the enterprise raised $1 billion in revenues and reached 2.2 millions of active customers while tech giants like Amazon and Trunk Club are imitating the service.[94]

Providing experiences

Providing personalized, amusing and suitable experiences is another application of AI technology. The final objective is to enhance customers' loyalty and revenues nevertheless it requires ambitious investments. AmazonGo, opened in Seattle in 2016, is the physical grocery store where customers can purchase without being checked out by human or automated cashiers.[95]
AI computer vision technology identifies and tracks shoppers and when they leave the store automatically charge them the cost of products they picked up from the shelves. This is an example of improved sales experience in-store. Still, Amazon is planning to go further. There is the project to complete the customer experience with the delivering of purchased products through unpiloted drones. These drones are equipped of AI computer vision and learning techniques which allow the robot to autonomously manage the whole transportation operation included the solution of occurring problems, such as the absence of the consumer at the time of delivering. The first delivery was completed in 2016.

However, AI is not only suitable for business needs but it could also be implemented in the education field. European Union is investing in the Talk2Learn project, an open source intelligent tutoring platform to help students with mathematics.[96] The platform

[93] Marr B. (May 25, 2018). Stitch Fix: the amazing use case of using artificial intelligence in fashion retail. Forbes.
[94] Gensler L. (Oct 19, 2017). Stitch Fix, with nearly $1 billion in sales, files for an IPO. Forbes.
[95] Wingfield N. (March 8, 2017). Amazon Moves to Cut Checkout Line, Promoting a Grab-and-Go Experience. The New York Times.
[96] http://www.italk2learn.eu/

combines machine learning algorithms, computer vision, and natural language speaking techniques in order to set up tutoring sessions and help students. Arizona State University employs an adaptive learning program aimed to support students with mathematics. Data show encouraging results: the exam pass rate improved by around 10 percent while the dropout rate fell by 7 percent.[97]

Also in healthcare industry AI applications are precious tools and significant strategic advantages. Turbine startup utilizes AI algorithms to design personalized cancer treatments therapies. Turbine servers display how cancer works on the molecular level and test millions of possible drugs on it every day on the digital model.[98] Turbine's fundamental cellular model and database grows by roughly 5-10 percent every few weeks.[99] The company was awarded as the startup of the year 2017 at the Central European Startup Awards.

The neuro-technology company Mindmaze offers neurorehabilitation virtual reality treatment for victims of stroke. The company raised $100 million in funding. A study reports the overall benefit of AI implementation in the healthcare industry. Esteems show a decrease in expenditures by 5 to 9 percent while an increase in life expectancy of up to 1,3 years more than the average. The global economic impact is valued from $2 trillion to $10 trillion.[100]

[97] Azcona D. Hsiao I. Smeaton A. F. Modelling. (2018). Math Learning on an Open Access Intelligent Tutor. School of Computing, Informatics & Decision Systems Engineering, Arizona State University.
[98] "Turbine.AI: exploding the status quo in cancer research", Medium.com, Dec 7, 2017.
[99] Ricci M. (May 5, 2017). The Simulated Cell: can a digital model aid cancer drug discovery? Pharmaphorum.
[100] McKinsey Global Institute, December 2016.

“Teachers will not be replaced by technology, but teachers who do not use technology will be replaced by those who do.” Hari Krishna Arya

II.2. Labor

Could new technologies cause mass unemployment? This is the basic question to which this part is aimed to give an answer, as long as just one an answer does exist. Because many experts tried to solve such issue and the results are often contradictory and solutions opposite.

Firstly, automation and AI do not take jobs, but tasks and competencies which are part of a job position. The degree which those specific tasks and competencies are automated does cause the total or semi absorption of a human job by machines. If all the tasks of a specific work position are automated, generally no human employees are needed. Equally, if the process of automation is partial, humans are still needed, time is freed and the work becomes integrated with new technologies. Directions are different but the result is always just one: the automation of tasks generates more efficiency.
In order to understand the impact of automation and AI technologies on human work, we have to make a distinction between work tasks.

The simplest distinction can be made by comparing through a two-by-two matrix cognitive versus manual tasks and routine versus non-routine tasks.[101] The nature of work is cognitive when is related to knowledge while manual if physical work. Routine tasks are those ones which follow the application of specific rules.

[101] Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerization? Technological Forecasting and Social Change,114, 254-280.

Work tasks distinction:

Cognitive – Routine sales and office occupations	**Cognitive - Non-Routine** management and professional occupations
Manual – Routine construction, transportation, production, and repair occupations	**Manual - Non-Routine** occupations related to assisting or caring for others

Table 2

Often non-routine tasks are related to higher skilled workers while the opposite is true for more routine works. The same is for wages that are indirectly correlated to the degree of routine. To higher wages corresponds to lower routine.[102]

Some studies suggest that about "47% of total US employment is…potentially automatable over...perhaps a decade or two.[103]" The same researchers indicate that lower paid, less educated and highly routine jobs are under immediate risk of automation; this is not what we are used to.

The 19th-century automation raises the productivity of lower-skilled workers threatening higher skilled ones. This was the sunrise of mass production society, the productivity raised, the standard of living increased while decreased inequality.

Today, the vulnerability of low paid jobs has amplified. The Council of Economic Advisers ranked jobs by wages and discovered that about 83% of occupations paid less than 20$ per hour are under direct pressure of automation, while, only 31% of jobs between 20$ and 40$ and only 1% for those higher than 40$ per hour.[104]

The share of Jobs with High Probability of Automation, by Occupation's Median Hourly Wage

[102] Autor D. H. and Handel M. J. (2013). Putting Tasks to the Test: Human Capital, Job Tasks, and Wages. The University of Chicago Press.
[103] Frey, C. B. and M. A. Osborne (2013).
[104] Frey, C. B. and M. A. Osborne (2013).

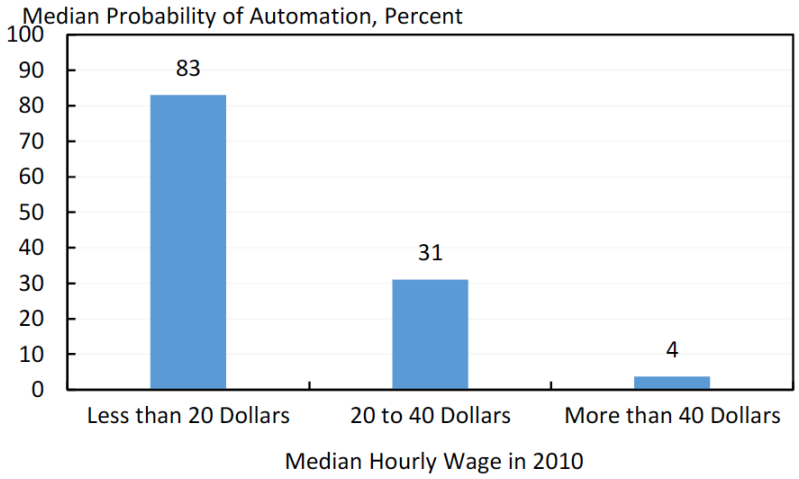


Figure 6

Source: Bureau of Labor Statistics; Frey and Osborne (2013); CEA calculations.

The graph below is the picture of rising inequality. At the same time, OECD analysis shows that less educated workers are under higher risk of automation than higher educated ones. In particular, there is a divergent effect on those workers who hold at least a bachelor degree which only 1% of them is likely to be completely automated while the percentage rises to 44% for those who do not hold any degree.[105]

The share of Jobs with Highly Automatable Skills, by Education

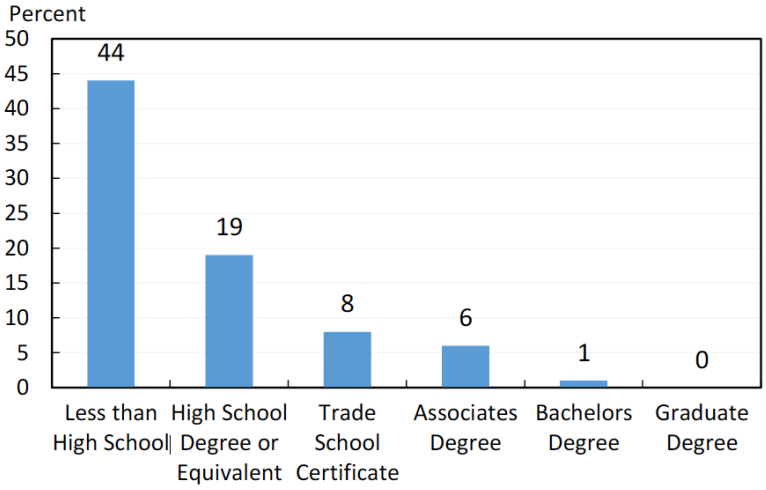


Figure 7

Source: Arntz, Gregory, and Zierahn (2016) calculations based on the PIAAC 2012.

[105] Arntz M. Gregory T. and Zierahn U. (2016). The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis. OECD Social, Employment and Migration Working Papers No. 189.

At the same time, evidence suggests that the nature of work and its degree of routine influences the unemployment volatility: routine manual jobs have higher volatility than non-routine cognitive jobs

Occupations requiring a higher degree of cognitive tasks have on the average a lower unemployment rate.[106] This evidence shows the vulnerability of such jobs were less educated and lower wages workers are employed. Furthermore, the process of offshoring and automation erodes in general routine jobs.

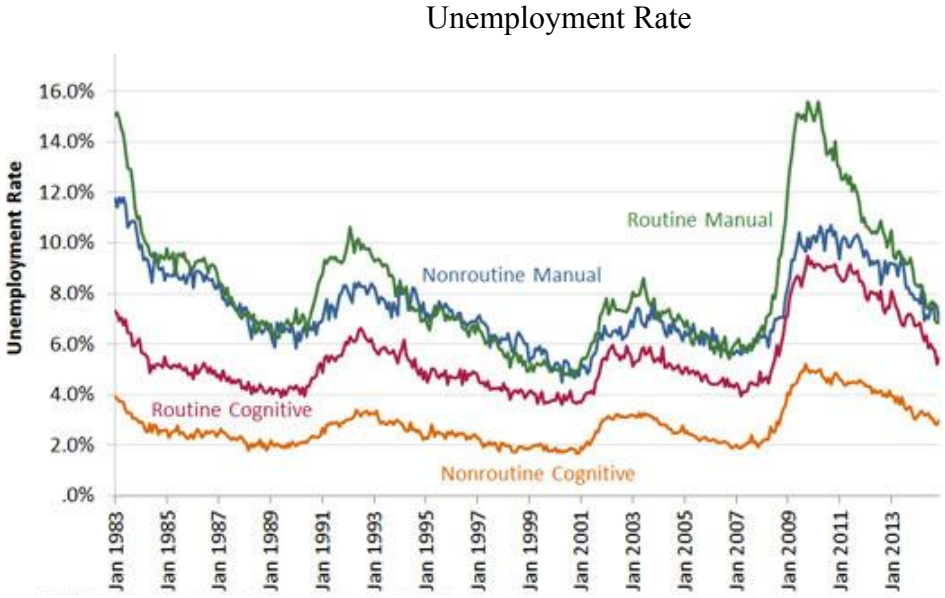


Figure 8

Source: Federal Reserve Bank of St. Louis

The starting point is to understand how the technologic innovation and automation actually affects jobs. Advancing technology enables machines and robots to perform and automatize work tasks usually executed by humans. While the direct automation of tasks increases the pressure on routine and lower skilled jobs, the surge of Artificial Intelligence extended the range of tasks that can be performed by robots through algorithms and learning machine techniques. Thus, today, also "white-collar" jobs are under risk of automation since computers demonstrate human cognitive capabilities and, often, control them better than humans do.

[106] Dvorkin M. (4 gen 2016). Jobs Involving Routine Tasks Aren't Growing. Federal Reserve Bank of St. Louis.

Furthermore, this is not the only way robots displace jobs. Technologic innovation disrupts entire sectors and makes products and firms obsolete. In the past, for example, the birth of car industry destroyed the carriage sector and displaced jobs but, at the same time, created completely new opportunities and flourishing markets. The rise of movie online streaming dismissed blockbuster chain but at the same time enabled the growth of online channels as Netflix.

At the same time technology change the organization of work. The diffusion of the Internet-enabled more efficient and diffused communication which allowed firms to outsource, offshore, decentralize more easily. The fluid flow of information on the Internet can ease the development of new markets as Airbnb or Uber while creating troubles to already established actors as taxi drivers and hotels.

Advancing technology and innovation have always destroyed and created new jobs; it is the process that Schumpeter called the "creative disruption".

II.2.a. Skepticals

Even though the rate and the extent of the of the new wind of automation are significant, there are many experts that are skeptical about robots taking human jobs.

The main reason is simple: we already heard that before. The automation fear is an old story; there were concerns already in the '20, in the late '30, still later in '70 and so on, when new machines started to automate many tasks in factories and farms reducing employment.

A significant example is what happened around 1870 with the disappearance of almost the totality of the agricultural workforce due to automation. In those years, more than the 70% of the population had a stable workplace in this sector; in 2016 that number is 2%.[107]

If we start to read some old articles from the newspaper without watching the date, they are incredibly contemporary.

"MARCH OF THE MACHINES MAKES IDLE HANDS

[107] focus on USA International Labour Organization, ILOSTAT database. Data retrieved in November 2017.

Prevalence of unemployment with greatly increased industrial output points to the influence of labor-saving devices as underlying cause. […] *One gasoline crane takes the place of ten or twelve laborers. The hod-carrier has disappeared before the invasion of material hoist. In concrete construction building materials are mixed like dough in a machine and literally pured into a place without the touch of human hand*[108]."
The New York Times, 1928.

"LABOR VERSUS MACHINES: AN EMPLOYMENT PUZZLE
Technical Progress Made in Last Decade Stress Anew Discarding of Men Displaced in Industry Scrapping the Worker. *What we call technological unemployment is not a new thing. The history of technical progress has had its parallel in suffering and retrogression among those wage earners from whom machinery had taken opportunity to do the work upon which they relied for a living.*[109]"
The New York Times, 1930

Albert Einstein complained machines as cause of unemployment:

"WORLD ILLS LAID TO MACHINE BY EINSTEIN IN BERLIN SPEECH *Says indus technique is about to overwhelm creators.*[110]"
The New York Times, 1931.

There are also voices defending automation, as Henry Ford in an article for the New York Times World's Fair Edition of 1939. He sustained that automation and machines would have produced more jobs than the number of displaced ones.[111]

After one year, the president of MIT Karl Compton and President Franklin D. Roosevelt discussed on the issue. The United States President had fears on automation.

"DOES MACHINE DISPLACE MEN IN THE LONG RUN? New Studies Cited as Old Argument Is Renewed. *Does technological progress, by increasing the efficiency of our industrial processes, take jobs away faster than it creates them?*[112]"

[108] Evans Clark, February 26, 1928The New York Times.
[109] William Green, 1930, The New York Times.
[110] Special cable to The New York Times.Oct. 22, 1931
[111] Ford Henry, (March 5, 1939). Machines as ministers to man, The New York Times World's Fair Section, The New York Times, New York,
[112] By Louis Stark, The New York Times, 25 February 1940, Washington.

While the first form of taxation over robots was not proposed by Bill Gates, but by Senator Joseph C. O'Mahoney in late 1940 in order to offset technological unemployment.

The issue continued to divide the public opinion. One article in 1955 says "President Dwight Eisenhower deplores fear of automation" which "*plagued people for 15o years and always proved groundless*[113]".

Some years later, President J.F. Kennedy proposed a different opinion:

"AUTOMATION MAY END 4 MILLION OFFICE JOBS

A report to President Kennedy estimates that machines will eliminate 4 million office and clerical jobs in the next five years.[114]"

The Washington Post 1961

"PRESIDENT RANKS AUTOMATION FIRST AS JOB CHALLENGE

He cites "burden" of finding work for youths and those displaced by machines.[115]"

The New York Times, 1961.

Anyway, the examples are many and it is clear that the "automation fear" is an ancient issue related to the advancing innovation and the diffusion of machines and robots.

Beyond all the positions and the opinions listed, what really happened until now?

First, it is true that automation displaces workforce. It destroys an entire sector of job which no longer exists. Technologic advances displaced around 8 millions of farmers in the U.S., 7million in the factories, more than 1million of railroad workers, hundreds of thousands of switchboard telephone operators[116]; elevator attendances do not exist anymore, as well as gas lamplighters, ice cutters disappeared after the invention of fridges, Telegraph Operators, Newspaper Typesetters.

[113] President Deplores Fear of Automation, Special to The New York Times, March 17, 1955.
[114] United Press International, The Washington Post, February 3, 1961.
[115] Peter Braestrup, The New York Times, New York, February 15, 1962.
[116] Ford, M. R. (2015).

Secondly, it is also true that while many jobs have died, work still persists. Indeed, it is easy to observe machines and robots taking jobs and positions, while it is harder to visualize what is going to happen next.

The direct application to the economy of new technology and automation causes, at the begin, loss of human employment while, at the same time, it creates only a few jobs for the tech suppliers and its maintenance. This is what immediately we can perceive creating concerns. However, we have to visualize the indirect and not instantaneous effects of innovation. Indeed, new technology causes higher productivity, a drop in production costs and better products. Thus, if prices are lower demand will tend to expand or will use higher sale capacity to buy other things. This would cause firms to expand because of higher demand and higher efficiency.
Entire new sectors would grow linked to new technology and the economy will tend to a new higher equilibrium. This process is what happened until now and, it is what has made our living standards grow in the last about one hundred years.

II.2.b. The end of work?

In 2016 *the Washington Post* implemented a new automated storytelling technology called Heliograph, a robot reporter provided of artificial intelligence able to write articles as a human journalist; the number is 850 articles published just in the first year.
This is an example of an article written by Heliograf:

> "The Landon Bears shut out the visiting Whitman Vikings, 34-0, on Friday.
>
> Landon opened the game with a 90-yard kickoff return for a score by Jelani Machen. Landon added to their lead on John Geppert's five-yard touchdown run. The first quarter came to a close with Landon leading, 14-0.
>
> In the second quarter, the Bears went even further ahead following Joey Epstein's four-yard touchdown run. The Bears scored again on Geppert's one-yard touchdown run. Landon had the lead going into the second half, 27-0. The Bears extended their lead on Tommy Baldwin's nine-yard touchdown reception.
>
> Neither team scored in the fourth quarter.
>
> Landon's top rusher was Geppert, who had nine carries for 59 yards and two touchdowns. Chazz Harley led Landon with 16 receiving yards on two catches.

Whitman's top passer was Landon Hawkins, who completed 4 of 11 passes for 22 yards and one interception. The Vikings' top rusher was Devin Carone, who had 19 carries for 111 yards. The Vikings' top receiver was Jonah Bird, who had one catch for 24 yards.

Landon will play St. Mary's-Annapolis High School (1-0, 0-0) on Sept. 8. Whitman will play Einstein High School (1-0, 0-0) on Sept. 8.[117]"

Heliograf does not only list data and facts, but it understands the most significant events of a match, summarizes and generates natural language sentences. *The Washington Post* states that the new technology will enable to cover more news which could not be considered before while enabling reporters to focus on the most important ones.[118]

Beyond these declarations, it is clear that the technology available today and in the next few years is potentially able to displace an entire sector. Heliograf demonstrates that the arms of AI have expanded the area of AI application involving those that were believed to be only human competence.

Quill, an algorithm developed by the startup Narrative Science, is used by top media providers to write articles on a sports matches, politics, and business, including Forbes.[119]

Also many summaries of financial information, such as quarterly reporting, today are written by machines. 9 of the 25 top asset managers use such technologies according to Narrative Science company.

Stuart Frankel, CEO at Narrative Science, declared on financial quarterly reporting: "It's a very manual process and takes a few weeks and a fair number of people for a family of funds. We have built a product and now we can do it in a few seconds."[120] Narrative Science offers products that report and process data into natural language for news, financial analysis, national security intelligence, hiring process, and marketing campaign. One of these products is Quill, an algorithm that collects a huge amount of data from transaction databases, social media, financial and sales reports; it processes information and identify the most important and relevant elements, in the end, lies down everything into a narrative report, without any human intervention. This means a reduction of time, errors and costs.

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[117] "Whitman at Landon" The Washington Post, AllMetSports, written by Heliograf, September 1, 2017.

[118] "The Washington Post leverages automated storytelling to cover high school football" By WashPostPR, September 1, 2017

[119] Ford, M. R. (2015).

[120] "Narrative Science Dynamically Automates Summaries Of Financial Information" Tom Groenfeldt, Forbes, Apr 18, 2016

According to the co-founder of the company, Kristian Hammond, in the next fifteen years, the percentage of news articles generated by artificial intelligence machines will be around 90%.[121]
Quill and Heliograf demonstrate that what once was exclusive competence of skilled or graduated educated professionals, now is vulnerable to direct automation.[122]

AI enabled computers not only to analyze and process data but, allowed them to learn, understand and imitate human language with the same cognitive process kids learn how to speak. Through deep learning technologies and the implementation of neural networks, designed on the human brain model, machines understand human speech and reproduce it applying the language-specific grammar rules, idiomatic sentences and even modulate the voice tone to each situation.

For example, the startup Lyrebird has developed an algorithm able to clone your voice and speak as humans do; it requires only one minute to recreate it artificially and it is able to say all kind of sentences with natural speech sound. Further, OkGoogle technology is not only able to speak naturally, but it understands the nuances and context of conversation while it also manages unexpected situations. These examples demonstrate that AI gave to computers the ability not to just reproduce, but also to speak with cognition of the reality and handle in critic way contexts and impulses from the external world.

This is not enough; AI went much further. There are cognitive abilities where humans do hold an unattainable advantage: curiosity and creativity. Not anymore. In 2009, Hold Lipson, the director of the Creative Machines Lab developed a program, called Eureqa, capable of discovering natural laws and conduct its own experiment independently.[123] The algorithm combines mathematical equations creating regressions. Eureqa tests them, selects the most promising ones and, in the end, it creates accurate mathematical models. Eureqa is a robot scientist.

[121] "Can an algorithm write a better news story than a human reporter?" Steven Levy, Wired, April 24, 2012.
[122] Ford, M. R. (2015).
[123] Ford, M. R. (2015).

"It is not a passive algorithm that sits back, watching. It asks questions. That's curiosity" Michael Schmidt declared.[124]

Eureqa is today diffused on the cloud, available and accessible from everywhere on the Internet and it is currently employed by scientists. The core technology of Eureqa is the "genetic programming", an automated invention the machine, that enables algorithms to design themselves through a process of "Darwinian natural selection" emulating the sexual reproduction.[125]

The computer scientist John Koza, one of the main researchers involved in "automated invention machines", argues that genetic algorithms have an advantage on the human mind, they act without preconceptions. There are 23 instances where genetic programming has duplicate already patented inventions, there are two instances where it has created completely new patentable inventions; 76 instances are mentioned to be competitive with human-produced results[126]. These computers made inventions that cover a wide number of scientific fields as electrical circuits, mechanical systems, photonic systems, other mathematical algorithms, software repair, scheduling, communication protocols and many more.[127]

This evidence suggests that creativity may be in the range of AI.[128]

In 2012 the London Symphony Orchestra performed "*Transits – Into an Abyss*", a track composed by Iamus, a musically inclined AI algorithm. Violinist and director Lennox McKenzie declared about this composition: "This piece is not the sort of thing that you listen to and then walk away whistling a tune, It's really quite large in sound. It reminds me a bit of Varese or Frank Zappa."[129]

Iamus technology is able to create, without human intervention, highly complex musical composition in a few minutes. Similar is Amper, an artificial intelligence music composer, and performer. The user selects mood, style, length and the algorithm creates

[124] "Distilling free-form natural laws from experimental data" Science 324, April 3, 2009.
[125] Ford, M. R. (2015).
[126] Koza, J.R. Genet Program Evolvable Mach (2010) 11: 251. https://doi.org/10.1007/s10710-010-9112-3
[127] J.R. Koza, M.A. Keane, M.J. Streeter, W. Mydlowec, J. Yu, G. Lanza, D. Fletcher, Genetic Programming IV Video: Routine Human-Competitive Machine Intelligence (Kluwer, Norwell, 2003)
[128] Ford, M. R. (2015).
[129] Sylvia Smith, 3 January 2013. "Iamus: Is this the 21st century's answer to Mozart?" BBC News,

a song in a few seconds. You can add instruments, picking melodies to be included in the track. Drew Silverstein, co-founder, and CEO of Amper music New York-based start-up declared: "Instead of solely feeding Amper data, we are fundamentally teaching Amper how to be creative."[130] Silverstein insists that "Amper serves as a collaborative tool to help musicians and non-musicians alike express their creative vision through music" and it is not aimed to substitute composers.[131] Nevertheless, it is clear that today we have created not only a technology that is potentially able to replace composers but, we have provided machines of one of the most human capacity, the creativity.

Hence, while it is clear that algorithms and computers are entering in the domains of science, engineering and even art, it does not mean they will substitute completely humans but it will enhance strong complementarities.[132]

However, the issue is not that technology will displace artists, musicians or scientists, but if computers are able to create a musical composition, produce and formulate patentable inventions, it is likely that, in the next future, they will have the capacity to define legal strategies or invent new management solutions. Today, many law firms employ algorithms that scan and process thousands of precedents and legal briefs for pretrial researches.[133]

The range of technological automation has never been so wide. This time is not the automation we have already experienced in the past industrial revolutions. This is particularly evident in the Wall Street Stock Exchange. Here, automated trade algorithms manage about the 70% of all stock market transactions. Operations that are not just mechanic executions of routine tasks but AI algorithms make forecasts and analyze the behavior of investors while trading a huge amount of stocks and pension funds. Bloomberg and Dow Jones Service sell products specifically designed to feed financial algorithms. They are able to turn news into highly profitable operations in a few milliseconds, a fraction of time humans are not even able to perceive. Furthermore, algorithms are not affected by human emotional weaknesses, they are rational investors.

[130] Magistretti, VentureBeat, March 2, 2017.
[131] Magistretti, VentureBeat, March 2, 2017.
[132] Carl Benedikt Frey and Michael A. Osborne. 2013.
[133] Markoff, J. (2011 March 4). Armies of expensive lawyers replaced by cheaper software. The New York Times.

A paper about financial markets published in the scientific magazine *Nature* suggests that the algorithmic financial trading evolution "can generate a new behavioral regime as humans lose the ability to intervene in real-time." The authors declared: "Transition to a new all-machine phase characterized by large numbers of sub-second extreme events. The proliferation of these sub-second events shows an intriguing correlation with the onset of the system-wide financial collapse in 2008."[134]

The issue is that a process of automation that is surging too fastly may run out of human control.

The advance in machine learning technologies has enabled algorithms to design and optimize themselves.[135] They are able to detect bugs and fix them without human intervention.[136] This evidence may suggest not only that, in the next future, machines will not need human intervention but, programmers might not be able to understand and control algorithms anymore since they are self-designed.

These examples suggest us that AI has expanded its range of application. Those tasks believed to be performed only by humans, in the next future may enter into the competence of algorithms and computers. AI has at least two comparative advantage with human intelligence:

1. Scalability. Computer's algorithms can manage at the same time more amount of data and calculations.
2. The absence of some human biases. While algorithms are designed to fulfill a specific task, human beings need to satisfy many other tasks and necessities such as sleeping, eating, socializing. These constraints reflect in biases.[137]

[134] "Abrupt rise of new machine ecology beyond human response time",Neil Johnson, Guannan Zhao, Eric Hunsader, Hong Qi, Nicholas Johnson et al. Scientific Reports Springer Nature Sep 11, 2013.
[135] Hoos, H.H. (2012). Programming by optimization. Communications of the ACM, vol. 55, no. 2, pp. 70–80.
[136] Hangal, S. and Lam, M.S. (2002). Tracking down software bugs using automatic anomaly detection. In: Proceedings of the 24th international conference on Software engineering, pp. 291–301. ACM.
[137] Kahneman, D., Slovic, P. and Tversky, A. (1982). Judgment under uncertainty. Cambridge University Press.

However, while AI competences are expanding, it is not always true that their introduction on the workplaces means the disappearance of human employment. The issue is that the majority of jobs will be automated only partially and no completely. We are moving forward a new nature of work.

II.2.c. Employment in the Twenty-First Century

In this chapter, we analyzed all the aspects and trends of work automation and, in particular, the impact of Artificial Intelligence. Experts are divided about the effects of such innovation on human labor. Some believe that the direct effect of new technologies will eliminate some human jobs but, at the same time, the increased efficiency will lead to the creation of completely new kind of jobs while the integration of already existing ones with new technologies. Other experts are more pessimistic. They believe that this time we are experiencing a different kind of change due to the different extent of innovation. Artificial Intelligence expanded the range of automation and will erode those occupations and tasks that require human cognitive skills that today computers are able to handle, even better than us. Thus opinions are many and widely divergent but all have a common point: artificial intelligence is already here and the effects will be deep and diffused in the next decade.

The theories we have exposed represent the majority of opinions in the economic and scientific community. All these are based on a single evidence, ongoing job automation, but the conclusions are only forecasts and hypothesis. There is nothing that is certainly due to the fast pace of innovation and the unknown effects and biases it may generate. This part of the research is aimed to analyze only the direct effect of Artificial Intelligence impact on human jobs in the next decade or two. The analysis is based on the model created by Carl Benedikt Frey and Michael A. Osborne for Oxford University and it is considered one of the most reliable. It is important to remind that this analysis focuses only on the direct effects and not on the indirect outcomes that may surge. No effects by a gain in efficiency and productivity are analyzed. This means that this model does not

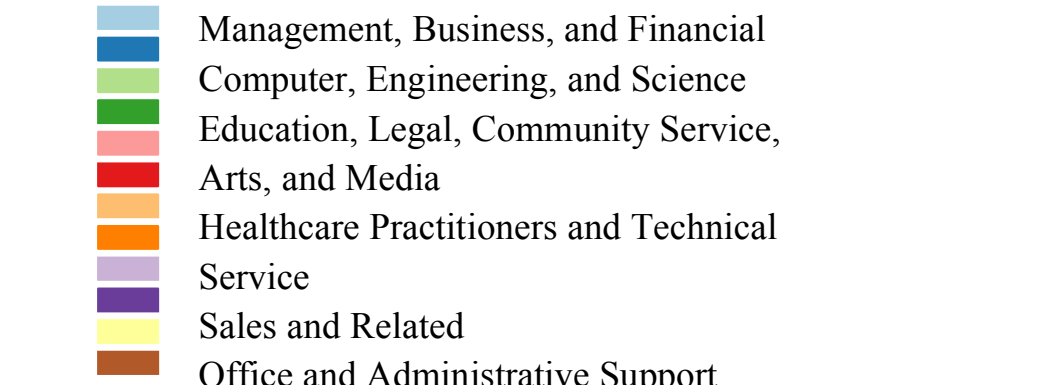
take into account the future composition of work and the changes that will occur but only the substitution effect of computerization.
The model is a speculation only on the technologies that are now at the early stage of development and it refers to breakthrough technological progress on the current employment situation[138]. For this reason, there are no existing historical data.
In the figure 9 , the whole spectrum of human jobs is divided into 12 kinds of occupational employment. The vertical axis represents the number of USA employed people and the sum of the areas of the single curves represent the total number. Specific extensions of each area represent the number of jobs included.

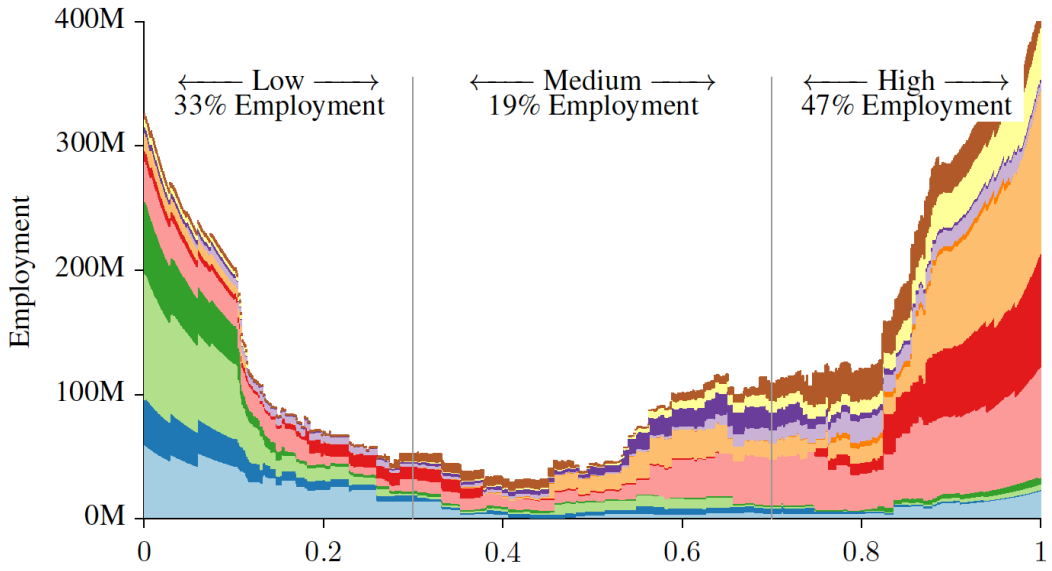
The horizontal axis indicates the probability of computerization of the job in increasing values from the left to the right. Furthermore, the share of employment is highlighted under the risk of computerization. There are fractions of the high, medium and low risk of automation jobs divided at 0.3 and 0.7 probability. According to this analysis around the 47% of jobs are under high and immediate risk of automation. However, in my opinion, it is not taken into account what degree of automation is. It can be total or partial. The estimation does not specify the quality of computerization. Beyond this, the risk of immediate loss of jobs is still high and does affect almost half of the employed population in the next decade. It is important to make clear that the horizontal axis can be also considered as a timescale. To a higher probability of computerization corresponds a more immediate moment in the time; thus, the time progression is from the right to the left.
Through this perspective, there are 2 distinct automation waves separated by a "technological plateau", which requires incremental technologic development.[139]
More specifically, the first wave will impact the high risk of computerization occupations which mainly involve office and administrative support, service workers, sales job positions, production and those related to transportation and logistics.
The latter ones are under pressure of evolving technologies for autonomous vehicles while the costs of advanced sensors are declining and flow of data surges. However, the automation may be partial since no laws will allow self-driving cars or trucks to move without the presence of an at least human driver on them; at least for the moment.

[138] For "current" we mean jobs existing in 2010.
[139] Frey, and Osborne (2013) "The future of employment: How susceptible are jobs to computerisation", Working Paper

Different story for office and administrative staff since the evolution of algorithms and data availability enhance the extent of artificial intelligence and realistically it may disrupt the sector.

Table 11. Probability of Computerisation





Data source: 2010 Bureau of Labor Statistic

Figure 9

Manufacturers workers are included in the area of direct automation since the high degree of routine and the implementation of mechanic robots always more advanced in dexterity. It more interesting the presence in the high-risk area of service, sales and construction jobs. According to the trend of technologic evolution in the service market, the implementation of robots is growing by around 20% each year and it seems really a high automation wave.[140] Sales jobs require a high degree of social intelligence and human involvement; however, the first wave of automation will impact the most routine task-based jobs such as cashiers, counter and rental clerks,
and telemarketers.[141] Big supermarkets already implemented automated cashiers while computers are able to handle commercial cold calls. In the construction sector, the rise of prefabricated building units and the always higher implementations of robots will allow the automation of many tasks and the pressure on current jobs. The new improvements in machine learning technologies will increase the intensity and the area of the impact of expanding the numbers of occupations under direct automation risk. However, according to this research to the first wave of job disruption, there will be a slowdown the authors call "technological plateau" because of "engineering bottlenecks".[142]
The engineering bottleneck is a phenomenon that causes the limitation of an entire process because of one single component of it.[143] In practice, this limitation in the implementation of innovative technology is represented by the time required to adopt the new technology to the concrete environment.

For example, the time for redesign car factories for the installation of mechanized robots. Furthermore, the technological plateau will cover the range of medium risk of automation job occupations and will be overcome by subsequent incremental technological improvements. The technology available is still not competitive with humans in the tasks that require manual or finger dexterity, or working conditions in narrow spaces. Robots are able to replicate simple human actions but they are still not able to handle more complex operations of perception and manipulation. Thus, if automation will occur in these areas of tasks, it may be eventually partial. For example, surgery is assisted by

[140] McKinsey Global Institute. 2013.
[141] Frey, and Osborne (2013)
[142] Frey, and Osborne (2013).
[143] Jean-Yves Le Boudec Nov 2005.

robots but not completely operated by them, both for complexity reasons both for a guaranteed issue; no patient would undergo an invasive procedure without the presence of a doctor able to instantly intervene.[144]

The last wave of automation will collide with the areas of creative and social intelligence, where only further improvements in artificial intelligence can arrive.

According to the graph "fine arts and originality occupations", "negotiation and persuasion", "social perceptiveness", and "assisting and caring for others" are tasks which lay in the area of low automation risk.[145] Those occupations require a deep knowledge of human and social heuristics and are far away from the possibility of computerization. Even if algorithms are able to create patentable inventions or compose music, it seems unlikely, at least in the foreseeable future, that they will displace jobs. For example, nurturing and elder-care occupations require a high degree of human emotional involvement, robots do not have feelings. Furthermore, the demographic imbalance is going to expand job opportunities in this field where the use of technologies can only assist humans.

[144] Ford, M. R. (2015).
[145] Frey, and Osborne (2013).

II.2.d. Skill-biased technological change

Wage and education level as a function of the probability of computerization In order to complete the analysis, there is evidence of relations between the level of job wage and education with the risk of automation.

On the left graph is plotted the average median wage in US Dollars with the probability of automation. The same for the right graph but the vertical axis represents the level of education. Both graphs show that there is a negative relation between the wage/education and the probability of automation.

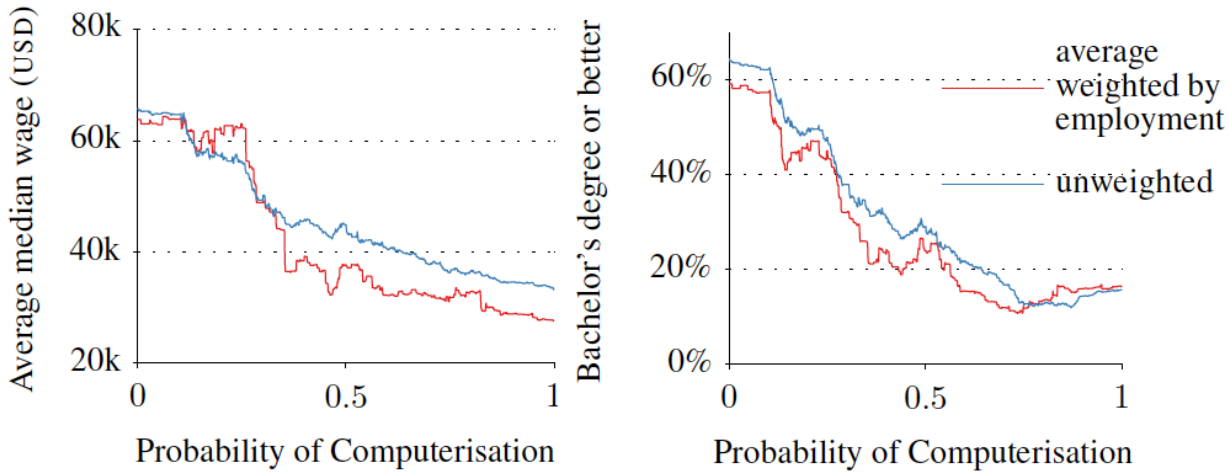


Figure 10

Data from 2010 Bureau of Labor Statistics on USA labor market

For example, the risk of automation is lower for those who hold higher degrees. In addition, the trend demonstrates a polarization of the job market towards higher wages weeping out the middle and lower income jobs, in the near term future. This is in contrast with the trend we experienced until now, where the job market was going towards a polarization of occupations between higher and lower income occupations.

The graph below reinforces these evidence based on the larger scale of OECD countries.

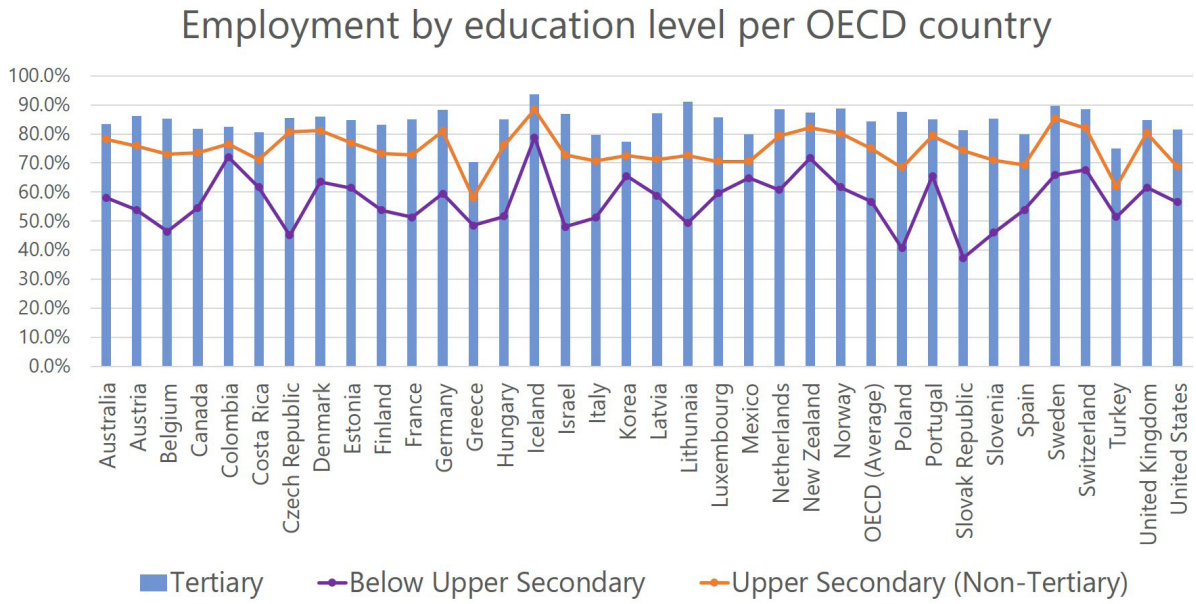


Figure 11

Source: OECD.

This is an evidence that put into the area of automation risk also those occupations that were believed as a safety net for lower income jobs. The disruption of technologies is going to corrode it. This phenomenon is the skill-biased technological change. The majority of benefits and economic value created by new technologies is going to distribute to the higher income and skilled workers, which represents the minority of the population.

According to this model, the artificial intelligence revolution is going to have a different impact than the other technological revolutions. The nineteen-century revolution in manufacturing displaced the higher skilled workers and creates workplaces for the lower income jobs. The twentieth-century computer revolution moved towards a polarization of works eroding the middle-income jobs, the twenty-one century will experience a completely different path.[146]

This model is based on the actual trends in technology and the recent developments in the artificial intelligence field. The forecasts are on a quantitative basis and do not take into account the subsequent changes into the quality of jobs, their degree of automation and the indirect effects of such automation.

[146] Goldin, C. and Katz, L.F. (2009). The race between education and technology. Harvard University Press.

In order to have a more concrete picture of the work market future, we have to consider three limitations that will affect the innovation process.

1. Labour saving inventions are implemented only if the access to cheap labor is limited or prices of capital are relatively high.[147] If labor is scarce its cost is going to increase more than the cost of capital creating the incentive to computerization, more profitable.[148]
2. We have to consider the political and regulatory rigidity to the application of new technologies. The political pressure of taxi drivers limited the proliferation in some areas of innovative services such as Uber. At the same time, regulations will not allow the presence of completely self-driving trucks on our highways.
3. We do not know the incremental e subsequent inventions that may evolve after the application of such innovations.[149] We ignore the spill-over effect. The analysis is limited in the near future and to the known actual inventions.
4. As we said before, it is not considered the degree and the quality of automation. it is not clear how the computerization of tasks will change the nature of work or will completely displace it.

Anyway, the impact of automation will hit the same nature of work and the effects will vary along the different sectors, occupations, and industries. There is a dangerous pressure on jobs and the immediate and direct effect of the application of new technologies will displace an important number of workers; 47% on the high risk of automation. However, it is hard to visualize what is going to happen later, what are the offsetting effects of automation and how the increased productivity will create new opportunities or entire new markets. Beyond the indirect effects and the evolution of the nature of work, today we are only able to predict only near-term future change in the distribution of benefits and economic value through the society. The trend shows emerging inequality and a growing pressure on lower-income occupations.

[147] Habakkuk, H.J. (1962). American and British technology in the nineteenth century: The search for labour-saving inventions. University Press.
[148] Acemoglu, D. (2002).
[149] Armstrong, S. and Sotala, K. (2012).

II.2.e. Superstar-biased technological change

The trend we analyzed seems to evolve towards the creation of larger inequalities between labor components. The skill-biased technological change is already creating an unequal distribution of wealth in favor of higher skilled and income occupations. However, some experts believe that this bias is only an initial step towards a more enhanced inequality.

Brynjolfsson and McAfee analyzed the growing trend towards larger disparity between labor and capital owners. The actual declining trend of wages in front of the increase of productivity led by a technologic AI drove change is creating a radical transformation in the distribution of economic benefits. The majority of economic value created by the AI revolution is going to be distributed to the capital holders rather than the workers, the vast part of the population. This trend is defined as "superstar-biased technological change".[150] The nature of such bias is similar to the one referred to skills, but this time the effects are even more enhanced and the benefits are projected towards an even smaller portion of the population. In the economy is going to establish a "winner take all" logic where the winners represent only the 0.01% of the population.

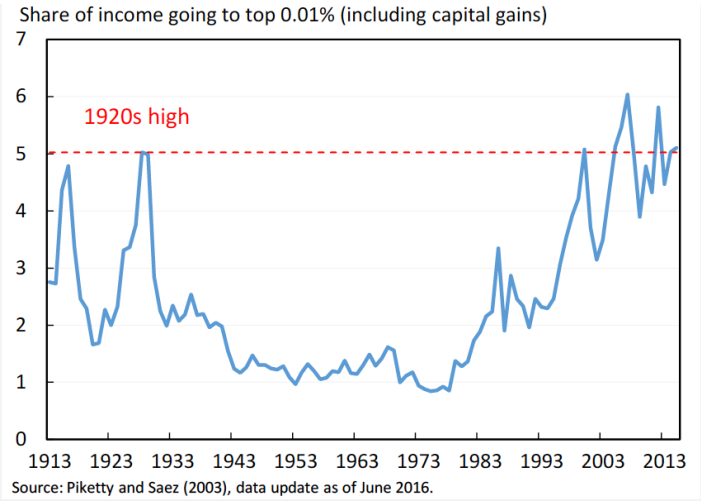


Figure 12

[150] Erik Brynjolfsson and Andrew McAfee, *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies,* WW Norton & Company, 2014.

The graph shows the trend of the top 0,01% income share of the population towards the last century. It seems that the declining need of labor due to the implementation of labor-saving technologies is going to corrode the wages of human work and, if the trend persists as it looks like, the disruption is not only temporary but is going to persist. If this is true, we are in front of the collapse of capitalism as we know it. If people do not receive wages, there will be no demand to meet the supply.
This means that the entire economic model we live in need to create a completely different approach to provide an allocation of resources rather than compensation for labor.

II.2.f. The future nature of work

Certainly, automation does displace workers but at the same time does create new opportunities while does not affect the total number of employment in the economy because of this kind of offsetting effects. Indeed, the direct application of AI technologies might enable indirect job creation to the degree it increases productivity and wages while rising consumption. This process allows the creation of new jobs across the whole economy and sectors.
For example, the diffusion of the Internet enhanced self-service technologies; today we are able to plan a trip, book a flight ticket or a hotel room by our own displacing thousands of hundreds of workers who were doing these tasks for us. At the same time, the costs of traveling are much lower and the tourism industry has strongly benefited, thus, new jobs have been created. Higher demand creates new workplaces.[151]

"Around 85% of the jobs that today's learners will be doing in 2030 haven't been invented yet. […] The pace of change will be so rapid that people will learn 'at the moment' by using new technologies such as augmented reality and virtual reality. The ability to gain new knowledge will be more valuable than the knowledge itself."[152]

[151] "Artificial Intelligence, Automation, and the Economy", Executive Office of the President (Eop), December 2016, Washington, D.C. 20502.
[152] "The Next Era of Human-Machine Partnerships" Dell technologies, Palo Alto, California, 2017.

This is what the Institute for the Future (IFTF) says in a report for Dell technologies in 2017. It is extremely difficult estimating if new technologies will be complementary or substitutive of human workers in the future. The Council of Economic Advisers, an agency within the Executive Office of the United States President, has individuated four categories of jobs that might expand in the next future driven by the growing AI innovation:

- Engagement. Humans will need to interact and engage with new technologies in order to perform their routine tasks. This is what is called the "Augmented Intelligence", considering technology as complementary to human work; it will lead to increase efficiency and facilitate tasks. For example, in the medicine, today doctors are supported by AI, such as IBM Watson, in the detection of cancer. Its technology is able to extract from an astonishing amount of medical data in order to help in diagnosing problems and elaborate patient treatment plans.[153] In this sector, doctors will never be replaced because of necessary human presence that can guarantee trust and control.

- Development. Especially in the early stage, the direct application of new technologies enables the creation of those specific jobs that allow the development, installation, and maintenance of such technologies. These are a technician, software developers, engineers. At the same time, AI will require scientists to feed robots with algorithms and data, teach computers how to solve problems or recognize and reproduce images, speech, music. Furthermore, the development of AI will open a completely new field of exploration for humanistic sciences for analyzing their social impact and discussing ethical issues.

- Supervision. New workplaces would develop for those tasks which include the monitoring, licensing and repairing of the new technologic applications. For example, the utilization of automatic pilot during flights is allowed only under strict control of a human pilot. The human presence has a role of supervision; nobody would travel on a flight without a pilot. Furthermore, the human control is necessary for the machines learning

[153] Houghton Mifflin Harcourt 2011.

the process in order to guarantee that AI does not deviate or degenerate from the wanted purpose.[154]

- Response to Paradigm Shifts. The implementation of new technologies will require the redesigning of the basic features of the environment. For example, regulations and infrastructures need to readjust to the presence of autonomous vehicles on the streets. It is what happened with the spread of the sharing economy, the diffusion of Airbnb or Uber. At the same time, not only the environments directly involved but also adjacent paradigm shifts will follow with the surge of new needs such as cybersecurity services or data scientists; completely new jobs.

Beyond new opportunities that may grow beside the innovation trend, we have to make an important distinction between the different effects of technological innovation: complete or partial automation. The former eliminates completely human workers, while, the latter can reduce their utilization partially, switch them to other markets or even increase jobs.

In reality, the most of automation is partial and not complete.[155] A research led by OECD highlighted that the most of occupations are likely to change and be partially automated or supported, while only 9% of jobs are under risk of complete displacement.[156]

It is not a high number but, 9% means millions of jobs only in the United States or in Europe; a social earthquake with devastating chain effects on the whole economy. In addition, the most magnitude of the automation wave will impact middle and low income and less educated positions.

In the 19th about the 98% of the work needed to produce a yard of cloth was mechanized but, actually, the number of jobs positions increased, for one simple basic reason. The automation led the cloth prices to drop down and the highly elastic demand increased.[157]

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[154] Ajay Agrawal, Joshua Gans, and Avi Goldfarb (2016). The Simple Economics of Machine Intelligence. *Harvard Business Review,*

[155] Frey, C B and M A Osborne (2013).

[156] M. Arntz, T. Gregory, U. Zierahn, (2016). The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis. OECD Social, Employment and Migration Working Papers No. 189

[157] Bessen, J (2015) Learning by Doing: The Real Connection Between Innovation, Wages, and Wealth, Yale University Press.

However, this is not what always happens, if demand is not elastic automation does displace workforce.

Another indirect effect of automation is the shift of the workforce from one specific occupation towards adjacent positions or markets. For example, this is the case of typesetters that were completely eliminated by rising of computers technology but, at the same time, it enabled the growth of graphic designer jobs.

Anyway, the introduction of new technologies and automation does displace jobs in the short-run but, in the long run, it creates completely new work or the shift of jobs to other adjacent markets. New workforce will be always more integrated with robots and machines. The same nature of work will change and evolve.

II.2.g. Technology under human control: Institutions and Policies

The core issue of the AI-driven technological change is to deal with the ability of the labor force to extract benefit from the increased productivity derived. While in the past the increasing productivity translated into higher wages and better living standards for lower and middle-income workers, today the situation is opposite. This means that the major part of the value generated by the higher productivity is absorbed by the capital holders and, always less by the workers in form of higher incomes.

The key question is: will AI technological progress enhance inequality? I analyzed the data and the different reports and opinions and it seems that, for now, the trend of the whole economy is in the direction of expanding the inequality gap.

The flow of the higher economic value generated by new technological improvements is divergent and the majority is running directly towards the capital owners while the pressure is always more overwhelming on the vast part of workers.

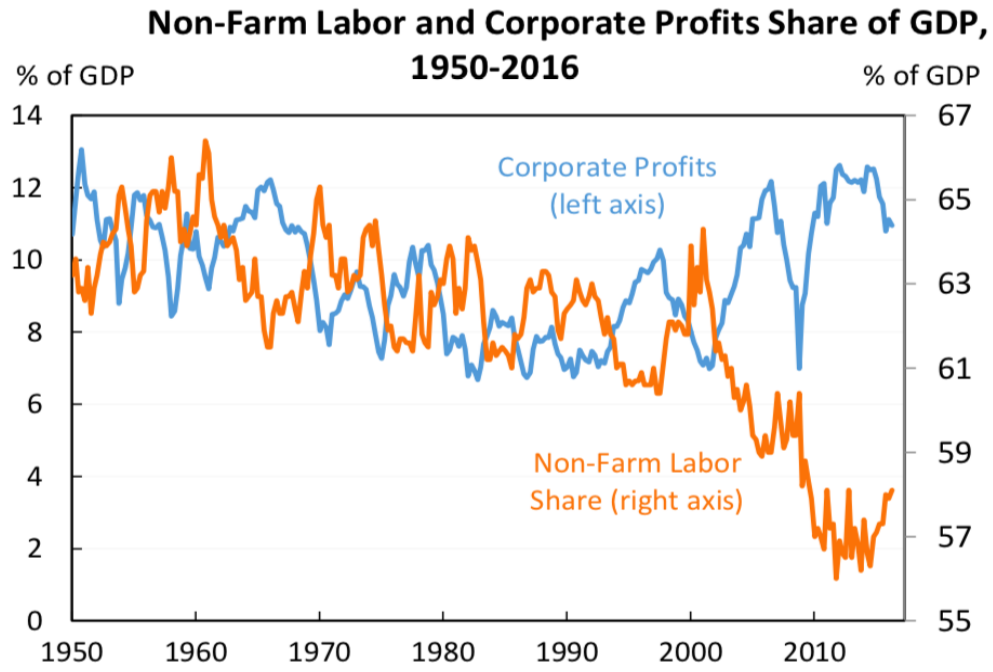

Figure 13

The graph is a picture of this trend. By the beginning of 2000 corporate profits, calculated as a share of GDP, started to surge while the share of labor earnings has begun a constant decline.

We are experiencing a concentration towards the capital holders of the majority of the value created by the economy, while workers suffer the constant drop in their salaries.

Thus, it does seem that the new technologies in the economy are enhancing the inequality gap and such trend has never been so emphasized. However, the solution is not so simple. There are other factors that amplify this trend such as the economic crisis of 2008 that increased the pressure on lower wages and the middle class or the globalization which allowed firms to deallocate production in low wages countries.

Technological progress is generated and adopted into the economy by choices of entrepreneurs, workers, and firms that are seeking to more efficient way to serve the market or rationalize the production process in the context designed by public investments and institutions, policies and applied research, infrastructure, and other public goods.[158]

In a process of technological change, incentives draw investment towards the most

[158] Daron Acemoglu, "Directed Technological Change, *Review of Economic Studies* 69(4): 781-809, 2003

profitable innovations and so the new technology applications that will be adopted are also the most profitable ones.[159]

Thus the soaring inequality is not a direct result of the technologic innovation, but the effect of the actual economic environment that is skewed designed. Its distorted evolution enhances biases and dysfunctions. This is happening because the current economic model is obsolete and it is not suitable for the emerging disruptive technology. While technology is evolving, as never before, it is necessary that also the economic model evolve or at least adapt to the new scenario. We cannot manage the intensity of such deep technologic impact without reshaping our economic paradigm. Thus, the issue is what is the role that institutions, policy maker and regulatory agents have in this new scenario.

The share of Income Earned by Top 1 Percent, 1975-2015

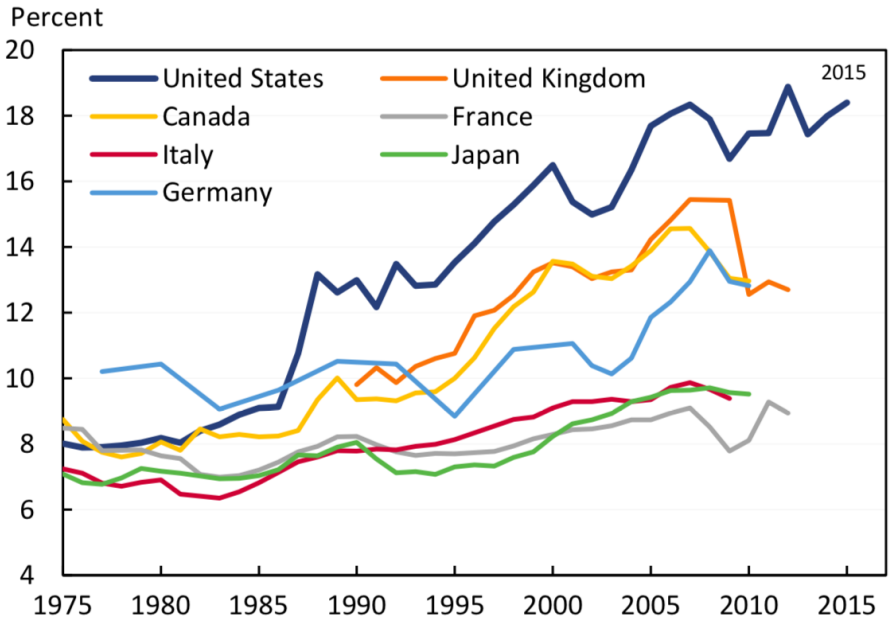

Figure 14

[159] Acemoglu, 2003.

II.3. The role of institutions

Policy and government play a fundamental role in shaping the effects and the direction of the technological change. While the AI disruption changes business models and drives the choices of firms and entrepreneurs in the economy, institutions are called to redesign boundaries and incentives in order to alleviate biases and unlock the potential of such innovation.

In this chapter are explained and analyzed the main public policies and institutional intervention proposed in the last years.

The content of this analysis is based on the most updated policies existing on the issue; many are suggested by the Executive Office of the President of USA, during the last months of the Obama mandate in 2016. Furthermore, I decided to deepen the issue by collecting the suggestions and the ideas from different sources and experts, independent from the public institutions, such as the analysis conducted by Microsoft Corporation.

AI-driven innovation will continue to create wealth and will lead the economic growth. New technologies will still increase the quality of our lives but, nevertheless, this growth has a cost and requires deep changes in the nature of work and the organization of our society. With the implementation of new technologies, new skills are required by workers and new strategies are necessary. Institutions are called to intervene in order to help those workers that will be disadvantaged and displaced by such changes in order to ensure that the huge benefits created by AI are accessible to everyone and developed in the best way.

Analysing the evidence, we have exposed in the previous pages, there are five effects that policymakers have to face:

1. Increasing productivity growth;
2. New skills required by the job market;
3. Inequality distribution of impacts across sectors, level of education, income, job type, and location;
4. Evolution of jobs;
5. Disappearing of jobs and increasing unemployment.

Experts are divided about the intensity of these effects and when they will emerge. However, the AI disruption raised a policy challenge and it is necessary for a policy response.[160]

In general, there are three main approaches that can be pursued by policymakers in order to address the raising AI revolution. These paths may be no alternative:

1. Invest in AI;
2. Re-educate workers for updated skills;
3. Capital endowment;
4. Social security aid for displaced workers;
5. Universal Basic Income;
6. Robot tax.

1. Invest in AI.

Investing in the development of AI means to control and direct the flow of innovation in order to unlock its potential and distribute benefits to all while alleviating the biases.

The main issue is creating a positive environment by the creation of a collaboration between the government, authorities, universities, and firms.

While the government provides funds, authorities shape the regulatory framework in which students and experts can integrate and bring energies to firms. In this scenario, the regulation has to support the market competition which creates the incentives for the adoption and development of AI innovation. The competitive pressure leads firms to cut costs and invest more in innovative solutions. The role of startups is crucial for the commercialization of innovation while their potential entrance into the market to incentivize incumbent firms to invest more in R&D. Where investments are required, there will be public funds and universities researches and skilled workforce.

The basic goal, laying below this strategy, is the attainment of the AI world leadership. In the AI global race governments provide funds, strategic plans, and investment funds. For example, the USA government has implemented a long-run strategy through the "*Artificial Intelligence Research and Development Strategic Plan*" in October 2016 and

[160] "The Future Of Employment: How Susceptible Are Jobs To Computerisation?",Carl Benedikt Frey and Michael A. Osborne, September 17, 2013

the institution of a federal fund. This strategy has been pursued also by Trump presidency by prioritizing funding for AI research and development while removing regulatory barriers to its implementation. The AI leadership is a strategic factor in the economic and political global scenario of the next decades.

However, China is actually the county that is investing more in AI technologies and it is predicted to become the AI world leader for 2030.[161]

Beyond this, AI is an important tool which can be pursued in order to increase the national cybersecurity system and the detection of frauds. At the same time, it is growing the need and the demand for specialists and researchers in the AI field to support its growth and development.

2. Re-educate workers for updated skills

Artificial intelligence and automation are changing the nature of work and the skills required of employees. The adoption of AI will cause the displacement of millions of jobs while, at the same time, the rise in demand for new occupation with different skills. In this direction institutions and policymakers have to create a system of re-education and re-training of displaced adults while preparing new generations for new tasks and occupations.

The whole education system and workforce training programs need to be deeply redesigned in order to provide workers of skills to be a complement to AI machines rather than compete with them.[162]

Furthermore, while AI may also be a key tool to provide wider access to education through the digitalization of libraries, the broadcasting online courses or simply the reduction of bureaucracy. Public investments in this direction seek to expand the availability of specific training and retraining programs. According to the data from 2016, the average spending for on active labor market policies in the OECD countries is 0,6%

[161] "China Is Quickly Becoming an AI Superpower" By Peter H. Diamandis, Singularity Hub - Aug 29, 2018

[162] "Artificial Intelligence The Next Digital Frontier?" McKinsey Discussion Paper June 2017

of GDP, a number that is way higher than the money spent in by US government that is around 0,1%.[163]

People affected by the AI revolution are those that already have a job, and are under risk of displacement, those that are entering in the job market, they may find significant entry barriers, and the younger generations that are still in the schools and require updated skills.

While training and retraining courses may be a good strategy to help the first and the last categories, for young graduates, time is an essential issue and the best path could be expanding the access to apprenticeships in order to adapt in the changing economy. Studies proof that apprentices usually earn up to $300,000 more in respect to their colleagues.[164]

Funds are required in order to incentivize firms to pursue such apprenticeship programs; in the USA such investments have been made by the government, for example in 2016 $175millions has been conferred.

3. Capital endowment

The main issue related to the rise of AI-driven automation is the tightening of the inequality trend. As we have seen before, for the first time in the history we are experiencing the concentration of the majority of the value produced in the hands of capital holders while the income of workers is constantly declining. Thus, the basic issue is how to fairly distribute wealth and value in the age of AI automation. Solutions to such concern follow two different paths. The first strategy is pursuing policies of social security aid and income redistribution through capital taxation. A different solution is conferring more capital to workers. According to Noah Smith, while everybody is born with an endowment of labor, everybody should also have born with a capital endowment provided by the state, a portfolio of financial asset. With some "lock up" restriction,

[163] Center on Budget and Policy Priorities, August 2016. Funding Down, Tuition Up: State Cuts to Higher Education Threaten Quality and Affordability at Public Colleges.

[164] Debbie Reed, et al. (2012). An Effectiveness Assessment and Cost-Benefit Analysis of Registered Apprenticeship in 10 States. Mathematica Policy Research.

citizens would receive a portfolio from the government and he/she will be able to sell it, hold it or invest in the creation of small businesses and startups.[165]

4.Social security aid for displaced workers

Job displacement can probably be the most immediate and severe effect of AI-driven automation in the next decades. If this is going to occur, the shock for the overall economy may be serious because of the fall in demand and related domino effect to the banking system due to the insolvency of many families. It is clear that without a growing demand the economy is going to collapse and there will be the need for way more public funds for displaced workers.

Pursuing a social security aid for such workers and job seekers is a strategy directed to ensure the possibility to lift consumers demand, allow a more efficient job placement and invest in the future generation The risk is that a massive number of layoffs may transmit into wider economic recession. A robust safety net can help to alleviate the shock of job loss; in this way, people are able to follow the job opportunities for which they are best qualified.[166]

However, the crucial issue of such policies is to help those displaced by automation but, at the same time, do not disincentive the research of other occupation. The regulator has to set the height of the safety net not excessively low to ensure its efficiency but, neither too high, otherwise, it may seem not convenient finding a job which provides lower or slightly higher wage. The level of the security net should stay below the minimum wage but still able to provide assistance to families in difficulty.

The ropes of the safety net can be composed of programs such as:

- unemployment insurance;
- Medicaid;
- Supplemental Nutrition Assistance Program, Temporary Assistance for Needy Families;
- Increase the minimum wage;

[165] Noah Smith 2013.

[166] Executive Office of the President (Eop), December 2016. Artificial Intelligence, Automation, and the Economy. Washington, D.C. 20502.

- Wage insurance;
- Emergency aid for families in crisis.

Investing in the unemployment insurance provides to displaced workers time and support to retrain and reinsert into the job market. At the same time there can be used innovative tools, in the USA has been proposed Work-sharing programs which allow employees to avoid layoff by decreasing the number of working hours and compensate with partial unemployment benefit.[167]

Wage insurances are designed to help those workers who lose the job and find a new one with a lower income. Data show that this is what happens the majority of times; incomes on average are 10% lower while it is worst for those who have at least 20 years of experience, the income is 25% lower.[168] Wage insurance programs alleviate such situations and decrease the risk of long-term unemployment or the left of the workforce.

Supplemental Nutrition Assistance Program (SNAP) is a powerful tool that can assure a critical security net through the provision of food and economic assistance for lower-income individuals.[169] In the United States SNAP is usually supported by the Temporary Assistance for Needy Families. These instruments provide individuals and families with the basic tools to survive and guarantee Medicaid and subsistence.

Increasing minimum wage may be an easier way to reduce inequality and sustain consumption. Data show that increasing it can lead to 4.6 million people out of poverty only in the United States.[170]

The reason why actually it makes sense investing in a strategy of Social security aids for displaced workers is related to the opportunity costs that may surge in case of serious workforce displacement caused by AI-driven automation relative to the collapse of aggregate demand. Furthermore, some experts believe that there is also another indirect effect that we have to take into account: The Peltzman effect. Peltzman basically demonstrated that the increase of safety perceived by individuals is compensated by an attitude more risk-prone. This effect has been demonstrated in many fields; for example,

[167] Carl Benedikt Frey and Michael A. Osborne, September 17, 2013
[168] The White House, January 2016. Fact Sheet: Improving Economic Security by Strengthening and Modernizing the Unemployment Insurance System. Executive Office of the President,
[169] Carl Benedikt Frey and Michael A. Osborne, September 17, 2013
[170] Dube Arindrajit, (2014). Minimum Wages and the Distribution of Family Incomes.

regulation implemented to improve driving safety did not result in a significant reduction of fatalities on the highways.[171]

While the Peltzman effect is usually raised against increasing regulatory regulation, some experts believe that people who have a safety net will be more likely to take the more economic risk.[172]

This may traduce in an increase in entrepreneurial activity since there is a guaranteed income. Moreover, job seekers may be incentivized to find better jobs relative to the one's skills and preferences.

However, pursuing such a strategy is not riskless since there are downsides and uncertainties to be discussed. The most immediate concern is whether or not create a disincentive to work. A guaranteed income may cause for a fraction of beneficiaries to simple take the grant and get out from the workforce. Some experts believe that it is not a negative effect. According to Martin Ford, if less ambitious and less productive people decide not to work, it is a positive thing for the whole economy since we are forced to compete for a job place, sometimes not always the most productive people succeed to get those jobs.[173] In this view, a guaranteed income may be an incentive for less productive people to leave the workforce.

Beyond the eventual biases that may arise, the basic goal of aid programs is to sustain the retraining and the fluency of labor market, while sustaining consumption and safety of families, individuals, and the whole economy.

4. Universal Basic Income

Concerns on a massive future job displacement caused by AI-driven automation made a rise in the proposal for a deep reform of the public assistance. Universal Basic Income, UBI, is the most ambitious social economic policy of our time. It essentially provides a basic income to the whole population without being taxed. In this paragraph, we will only

[171], Barrat James, Dunne Thomas 2013. Our final invention: artificial intelligence and the end of the human era.

[172] Ford, M. R. (2015). Rise of the robots technology and the threat of a jobless future. New York, NY: Basic Books.

[173] Ford, M. R. (2015).

discuss the minimum universal basic income that is the one planned to guarantee a wage above the poverty level. Many ideas of UBI do exist considered as an alternative to welfare state or policy which may be an expansion of it.

If layoffs will be huge and the society will no need human workers anymore, there will be the need for a tool that will substitute the work income and the demand. UBI is a tool that distributes the overall value created by the society to all citizens remaining the free market intact.

Canada implemented an experimental policy of UBI in 1970 called the "mincome" for groups of selected families. Based on the size of the family was provided a minimum cash benefit diminished by a specific amount for each dollar earned by working.[174]

Results describe non-significant changes in the job market while on average there was a reduction of 10% of working hours.[175] Some experts believe that such light drops derive from the knowledge of participants that the experiment was temporary.[176] Thus there are no proofs about the efficacy of this policy.

Furthermore, the implementation of UBI instead of the welfare state would be funded with the same money and it would reduce costs related to bureaucracy. It is also proved that by providing United States citizens of $1000 of guaranteed income the GDP would surge by 12% in 8 years.[177] The same research states that by financing UBI with higher taxes there is no effect on the economy because higher taxes would be displaced by a guaranteed income.[178]

Moreover, the basic income would be economically efficient because taxes on spending through VAT would increase revenues to the government. To some extent, we can state that it pays for itself.

However, there are downsides and uncertainties we have to consider. UBI can create a strong disincentive to work, it requires the complete redesign of the security system and welfare mechanisms and it could cause increasing inflation.

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[174] Robert Longley. "Mincome: A Guaranteed Income for All Americans: Eliminating poverty or the incentive to work?".

[175] Hum, Derek; Simpson, Wayne (1993). "Economic Response to a Guaranteed Annual Income: Experience from Canada and the United States". *Journal of Labor Economics*.

[176] "Improving Social Security in Canada—Guaranteed Annual Income: A Supplementary Paper". Canadian Social Research Links. 1994

[177] Michalis Nikiforos, Marshall Steinbaum, Gennaro Zezza. 08.29.17

[178] Michalis Nikiforos, Marshall Steinbaum, Gennaro Zezza. 08.29.17

Criticisms state that the goal should be foster training, skills and assist job research in order to help people in finding the best job without creating a policy projected to alienate people from work.[179]

5. Taxation and robots

The United States government is funded by roughly 80 percent of taxes coming from individual income or payroll taxes.[180] The latter is used to fund the social security system while the former represent around the 47 percent of the total tax revenue of the government.[181]

The Italian government budget is funded by around 36 percent of individual income taxes.[182]

This means that there is a high degree of government budget vulnerability and dependency from the revenues coming from the income of workers; even for a small number of job places displacement, there are significant effects on the government budget.

Bill Gates was one of the first to call for a realization of taxes on robots because considered normal workers.[183] Implementing such a tool will allow the government to dispose of enough funds to invest in social security policies, training programs while slowing down the automation trend. Even if there are divergent opinions about the speed of the automation trend and its dimension, there is a common agreement that at least 10 percent of the actual workforce are under high risk of immediate automation.

Moreover, there is no precise idea about how a robot tax would work. Bill Gates suggested taxing those profits generated by labor-saving technologies. The European

[179] *Excerpt from* a *speech by CEA Chair Jason Furman, in New York, July 7, 2016*
[180] Tax Policy Center Briefing Book, USA, 2016.
[181] Office of Management and Budget. Budget of the United States Government, Fiscal Year 2018, Historical Tables. Table 2.1. "Receipts by Source: 1934–2022" and Table 2.3. "Receipts by Source as Percentages of GDP: 1934–2022."
[182] Ministero dell'Economia e delle Finanze, Bilancio dello Stato LB 2017-19
[183] Kevin J. Delaney, Quartz, February 17, 2017. The robot that takes your job should pay taxes, says Bill Gates.

Parliament meeting in 2017 declared "levying a tax on the work performed by a robot or a fee for using and maintaining a robot should be examined in the context of funding the support and retraining of unemployed workers whose jobs have been reduced or eliminated."[184]

A portion of jobs under high risk of automation according to different opinions:[185]

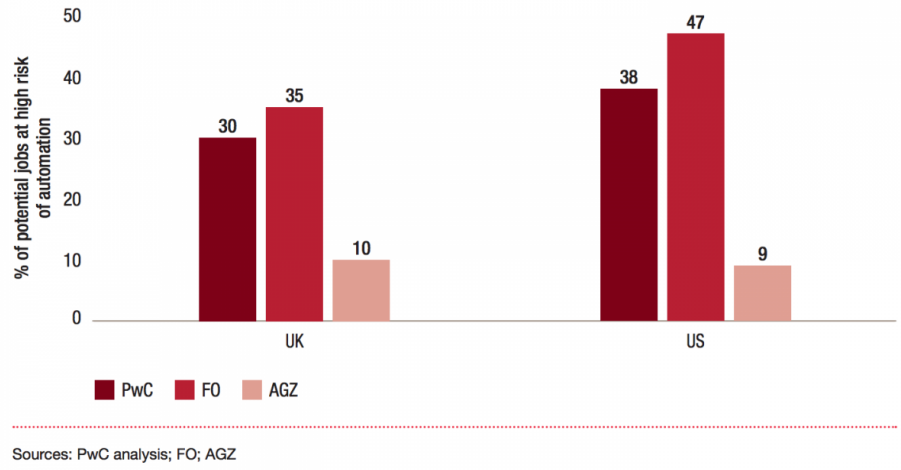


Figure 15

The most complicated step is defining what a robot is. What is the difference between a tool from a robot or a complex computer program from an AI application?[186] A vending machine can be defined as a robot? Furthermore, manufacturers could eventually modify some aspect of the robot to make it appear as a normal tool. Defining what is a robot will create never-ending legal controversies.

[184] "Motion for an European Parliament Resolution" with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)) Committee on Legal Affairs
(Initiative – Rule 46 of the Rules of Procedure).
[185] Graph data source Arntz M. Gregory T. and Zierahn U. (2016). The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis. OECD Social, Employment and Migration Working Papers No. 189.
[186] Walker J. (October 24, 2017). Robot Tax A Summary of Arguments For and Against. TechEmergence.

However, South Korea was the first to implement a sort of "robot tax" in the form of reducing incentives in automation investments.[187] A robot tax can be realized also as a form of tax break for those firms that keep the level of human employment stable. In the same direction, the government could tax companies earning high profits with relatively low human workforce used in a form of a worker per profit ratio.

There are though numerous arguments against a form of robot tax. Many experts are skeptical about the impact of AI-driven automation. The economist Dean Baker states that data do not show such sustained productivity growth. Based on the analysis of the US Bureau of Labor Statistics, productivity rose by 1,2 percent in the last 10 years while only 0,6 percent in the last five; this is much lower of the level between 1947 to 1973.[188] Thus taxing productivity can only be harmful to the economy and work market.

Andrus Ansip, the European Commissioner to the Digital Single Market is strongly against such an idea. He believes that with the implementation of a robot tax in EU, "somebody else would take this leading position."[189] The risk of the enforcement of robot tax would cause companies simply to move towards other countries. An alternative way would be instead of taxing the workforce with individual income taxes, the government should tax capital gains and high corporate revenues. Since earnings created by automation higher productivity, instead of going towards employees, are directed to capital gains and higher dividends. Thus the issue could be faced by enforcing more tax emphasis on capital gains while making more convenient hiring human workers reducing taxes on them.

[187] Walker J. (October 24, 2017).
[188] U.S. Bureau of Labor Statistics, Productivity, January 2017. Vol. 6 / No. 2
[189] Kharpal Arjun. (2 June 2017). Bill Gates wants to tax robots, but the EU says, 'no way, no way'. CNBC.

III. Elaisian business case

Elaisian is a bright example of artificial intelligence integration as core of the business model. This business case is provided in order to support the study with the concrete story of a successful start-up which took through the new technologies the opportunity to grow. In particular, this company utilizes artificial intelligence applications such as machine learning and predictive algorithms in the food tech industry. The study and the information are provided through a numerous interview with co-founder and CMO Giovanni Di Mambro.

III.1.Elaisian's story

III.1.a.Company overview

Elaisian is a precision farming service focused on the preservation of olive trees. Thanks to a system of algorithms based on a database of agronomic studies and machine learning techniques, the company is able to prevent diseases and to optimize cultivation processes such as irrigation and fertilization. With its technology, olive oil producers are able to constantly monitor the situation on the field through sensors and installed on the ground. These devices collect climatological data, chlorophyll and soil components. The algorithms process information and through machine learning and other databases, provide real-time information on the status of trees and suggest advice. Farmers receive science-based suggestions on optimizing irrigation and the efficient use of fertilizers. Elaisian's devices gather climatological data such as rainfall, humidity, temperature and analyse chlorophyll and beta-carotene levels. At the same time, the intelligent software pre-warns producers on diseases and enables treatment when disease attacks. Elaisian utilizes AI to elaborate and predict the behaviour of the land by providing increasingly precise insights. The algorithm learns exactly when, where and for how long to irrigate cutting costs and wastes. The brain is the company platform where all data and information are transmitted through Wi-Fi. An algorithm process data collected on the ground and cross-reference with other source such as historic database, weather information, satellite images and other agronomic data. The purpose is to improve the life

of the olive tree and the performance of the producer. Intelligent technologies maximize the production and enhance cultivation processes.

Every year 60 percent on average of olive oil production is lost, due to inefficient tools. According to Elaisian the operative costs are reduced by 20 to 30 percent while production is enhanced up to 20 percent more.[190] Thanks to water monitoring CO2 emissions in the production process are cut by more than 18 percent. 70 percent of world water consumption is used in agriculture, of which the 50 percent is wasted. Irrigation expenses have a fundamental impact on operative costs. Intelligent algorithms are able to drop these costs and increase water consumption efficiency.

Elaisian was born in November 2016 from the idea of co-founders Giovanni Di Mambro and Damiano Angelici. After three months of development path, the start-up is officially established after the success and the victory at the accelerator program StartupBootCamp Food-Tech in Rome.

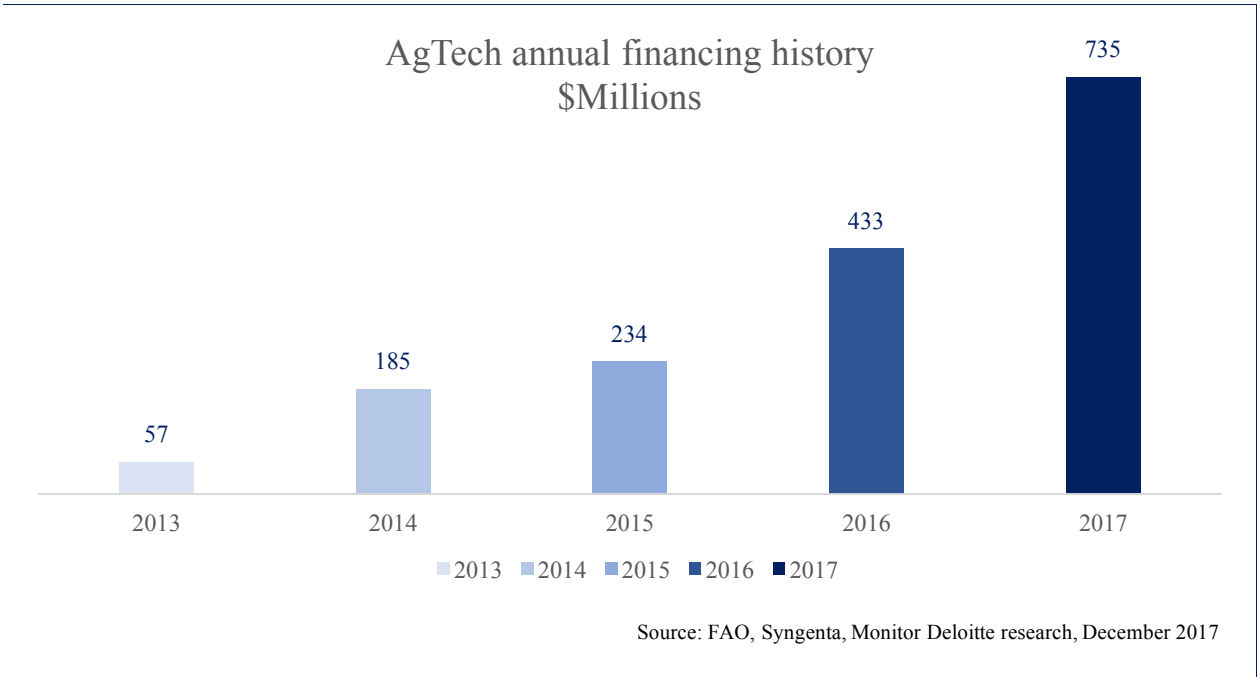
From a financial prospective, StartupBootCamp made the first investment of €15.000 and the 6 percent of company equity. This investment enabled the implementation of the first minimum viable product and the creation of commercial partnership and advisory from top manager of start-up ecosystem and European-Italian food industry. After three months of entrepreneurial path, Elaisian attended the "Demo Day" event in front of an audience of more than 300 investors. The event raised additional cash and investment which enabled the deeper improvements and a commercial development of the product.

Today the team is composed by 6 people, the CEO Damiano Angelici, CMO Giovanni Di Mambro, 1 agronomic expert, 2 IT engineers and 1 salesman. In July 2018 new funds were provided through a crowdfunding campaign on Mamacrowd online platform raising the amount of € 122.000. Elaisian is in 11 Italian regions with 50 olive oil farms and 80.000 olive-trees monitored.

[190] Data from company Elaisian source.

III.1.b. Market analysis

Elaisian an agricultural business intelligence solution founded on in-field measurements. The company operates in the food tech industry providing business to business service in the agriculture pre-harvesting production phase. In particular, Elaisian is specialized on the olive oil production. [Table 18]



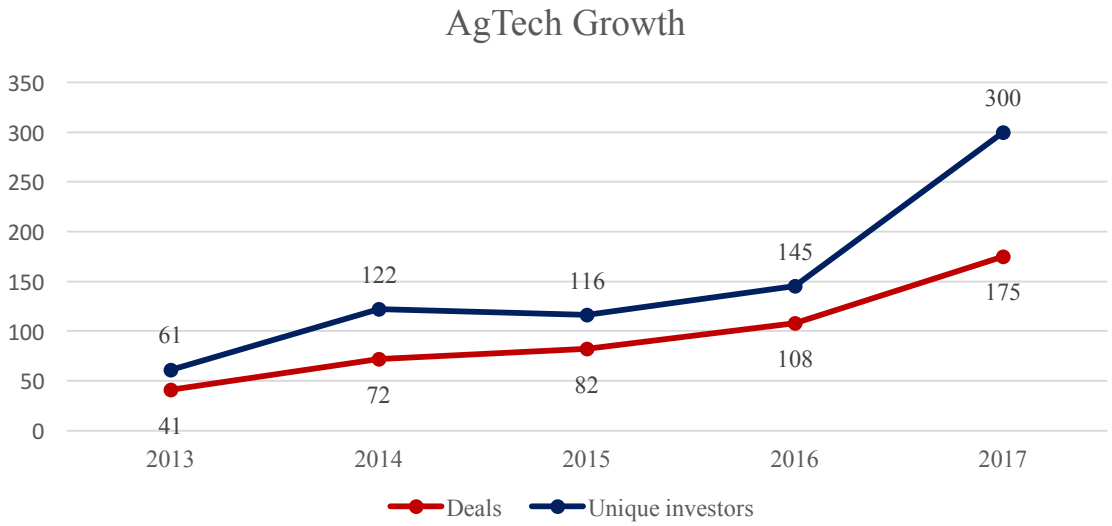
Source: FAO, Syngenta, Monitor Deloitte research, December 2017

Figure 16

In general, the reference field is the agriculture tech sector that aims to increase farm efficiency through software, sensors, aerial-based data, internet-based distribution channels (marketplaces), and tools for technology-enabled farming.[191] Interests and expectations are growing in this market since the acquisition of "the Climate Corporation" by Monsanto for more than $1billion in the 2013. Climate Corporation was one of the first to move in the collection of field data for farmers in order to enhance productivity and optimize costs. The billionaire acquisition increased the attention on the sector.

In 2017 the amount of funds and investments in Ag-Tech has nearly doubled surpassing $700 million globally. In the same year in the sector there were more than 300 unique investors and more than 160 deals, contrasting the 31 deals and less than $200 millions of investment in 2007. [Table 19]

[191] CBInsights from Ag tech industry, 2018.



Source: FAO, Syngenta, Monitor Deloitte research, December 2017

Figure 17

Corporate venture capital has raised interest in the sector, there are now more than 30 active funds, plus the agtech-focused funds like Khosla, Fall Line, Finistere, Innovation Endeavors and S2G. In this landscape, data-driven agronomy implemented with artificial intelligent tools is the new trend of the market. the implementation of on-field sensors and artificial intelligence platforms are driving the evolution from precision to "predictive" agriculture.[192]

Table 3

Rank	Country	Production in Tonnes, 2016-2017
1	Spain	1.290.600
2	Turkey	208.000
3	Greece	195.000
4	Italy	182.300
5	Morocco	110.000
6	Syria	110.000
7	Tunisia	100.000
	World Production	2.586.500

Source: International Olive Oil Council

[192] https://techcrunch.com/2018/03/08/major-trends-in-agtech-for-2018/

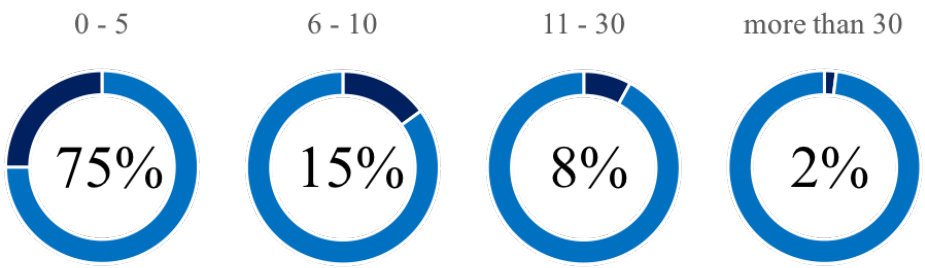
Table 4

Rank	Country	Production in tons (2016/2017)	Production % (2016/2017)	Consumption (2016/2017)	Annual per-capita cons. (kg)
	World	2,586,500	100%	100%	0.43
1	Spain	1,290,600	49.9%	16.7%	13.62
2	Turkey	208,000	8.1%	5.5%	1.2
3	Greece	195,000	7.5%	3.9%	23.7
4	Italy	182,300	7.1%	16.1%	12.35
5	Morocco	110,000	4.2%	4.4%	11.1

However, the sort of Elaisian depend also on the olive oil market. The company is the only firm specialized in Ag-Tech for olive oil production and it is established in Italy, the fourth largest olive oil producer and the second consumer in the world.

However, Italy represents a profitable market. there are 3,5 millions of oil producers, only in Italy there are more than 850.000, hobbyist included. The 75 percent of them is composed by small firms with up to 5 employees. The target of Elaisian are only the firms which constitutes roughly from 25 up to 35 percent of entire market.

Number of employees for farm in Italy:



Data from Agrinnova 2016

Figure 18

III.1.c. Competition analysis

The broader competitive landscape is dominated by the two largest players Dow/DuPont and Bayer/Monsanto which control diversified segments in the market. At the same time, non-traditional new entrances are approaching the sector through partnerships and M&A. Most of these are digital giants that are exploiting core competences such as Google on data, Amazon relying on its supply chain Facebook on connecting and selling to farmers.[193]

For what concerns Elaisian, the strategic market of reference is the in-field measurements through sensors. This highly competitive *sector* with a large number of start-ups. However, Elaisian is the only existing start-up specialized on olive oil. Furthermore, the geographic diffusion of olive trees delimitates the range.

Competitive landscape for Ag-Tech market

Figure 19

Data from CBInsights 2017

[193] Agrinova database.

The reference sector is the widest Ag-Tech but, in particular, Elaisian is active in the Precision farming, sensors and data analytic segment. The most direct competitors are companies like Revotree, Agricolus, AgCode active in Italy.

Revotree is a start-up specialized in "scalable Internet of Things system for Ag-tech to monitor water needs in large rural areas, manage water supply and save resources thanks to AI."[194] The service provided is basically the same. Both Elaisian and Revotree provide in-field data collector devices connected through Wi-Fi and cloud system to the company database and algorithms which elaborate forecasts and advices. However, Revotree is focused only on the water wastes reduction, while it is directed towards no specific kind of cultivation. The opposite is for Elaisian which is specialized in one farming sector, the olive oil, while includes wider amount of aspects. Furthermore, Revotree can be more assimilated to the segment of smart irrigation.

Agricolus is a start-up working on precision farming. It is a potential direct competitor since the service and the modalities through which it is delivered are quite similar. As Revotree, there is also the utilisation of sensors and big data intelligence analytics. Moreover, the target customer is a general farm business. Differently from Revotree, Agricolus is not focused on water management but it involves the treatment of other resources.

AgCode is also active in the precision agriculture through implementation of in-field sensors and big data intelligence analytics. Its product is addressed to all kind of farming and involves wider applications. While Elaisian is specialized in the production phase of pre-harvesting delivering a service concentrated on olive-trees and all related aspects. AgCode is more a general service that involves payroll, governance management, budgeting, billing and equipment tracking. Agcode addresses to a different market but, though, in some aspects it may reach the Elaisian target customers.

[194] https://www.crunchbase.com/organization/revotree#section-overview

III.1.d. SWOT analysis

Table 5

Strengths	Weaknesses
AI expertise Olive oil specialization Vast specific database Strong geographical penetration Ecosystem AI technologies flexibilities	Small firm Strong dependency on AI expertise
Opportunities	**Threats**
Growing population Climate change Emerging technologies Huge market potential Sustainability request Growth of olive oil market	Climate change High competitive level Lack of expertise on the market Olive-trees illness Weak digitalization of the market

Elaisian can count on AI expertise provided directly by partnership with the Perugia University. This is one of the most relevant strength because the relationship between company, university and local farms creates a favourable ecosystem. This is enhanced by strong geographical penetration in Italy, one of the main producer of olive oil in the world. Furthermore, the geographic concentration of olive oil production can be a positive factor for company logistic; the 80 percent of olive-trees are in the southern regions. Focus on a smaller specific area may enable economies of scale and scope for what concerns data collected on the territory. This strength has been pursued in the last year with the expansion in the Spanish market. Spain is the largest global olive oil producer and consumer; its farms harvest almost the half of the world production. Elaisian can take advantage on its brand, trustable and specialized on olive oil. This allows the company to build more precise and specific data on a single objective.

This strength may be useful to face the increasing competitiveness on the market. Since higher volumes of investments are flowing in the Ag-Tech, the interest of biggest player,

both inside and outside the industry, is growing. Numerous start-ups are growing specialized on in-field measurements and many of these are backed by large venture capital investments funds or multinational tech giants. Until now, Elaisian is not the only firm in this sector but, it is the only and the first to specialize on olive oil. While in the Mediterranean area there are still no big competitors, in the US market, there are dozens of new companies. The area of larger diffusion is the California, where is placed the Silicon Valley and the weather is Mediterranean. Thus, the probability that one of this, or a new one, may specialize on olive oil is moderate. What can be a threat can also be an opportunity. If big investors are willing in the future to penetrate in the Mediterranean area could also decide to acquire Elaisian and offer a rich exit strategy. However, the presence of big investors and the lack of AI expertise may raise the price of the few technicians able to run intelligent complex system. Beyond this, another threat that may be also an opportunity is the diffusion of olive-trees illness. The business of Elaisian, for now, is strongly related to the performance of olive oil producers. While the fear of trees illness is a strong incentive for farmers to adopt control system, if the disease become uncontrollable it would devastate an entire sector. However, in the last decade, there is a growing interest for high quality olive oil, more often compared with wine. This is a good sign for Elaisian since its dependency on this sector. Furthermore, rising ecological concerns are prompting the need for sustainable food options that have the lower impact on the environment.[195]

Growing population drives the surge of demand. Combined with climate change challenges, creates a severe urgency to increase yields efficiency and optimize the exploitation of natural resources like water. Climate change can be both an opportunity and both a threat that increases the complexity of efficient fields management.

[195] Abhishek. (2018).

III.2. Technological Readiness

Measuring the technological readiness of farm industry means detect rate of resistance to new technologic tool and innovation. If one industry is already digitalized it will be easier to launch new updated tools. This is particularly significant for companies like Elaisian and for innovations such as intelligent machines.

According to a survey led by Ibm and Wired, in Italy 75 percent of farmer is interested in big data, sensors, drones and genomics; the 30 percent is planning to implement such technologies and 10 percent of them has already employed them.[196]

In Italy, the only the 26 percent of farms companies is not online while 66 percent of them claim to be "innovative" which it is realized in the productive process for the 81,9 percent of them. The productive process is the step of value chain in which Elaisian provides its services. The data suggests high attention of farmers on the efficient utilisation of natural resources and reduction of wastes which impact more on operative costs. The same research indicates that the leading technology is the utilisation of drones for fields monitoring, while the second most appreciated is the "sensomining", in-field sensors for precision agriculture. However, nevertheless such technologies are widely valued by farmers, their diffusion is still low. Almost 70 percent of respondents is not willing to implement new technologies in the short-run. It emerges, though, that the most diffused innovation is the one relative to sensors and big data analysis.

According to Elaisian research, olive oil farming has still low digitalization rate which states around 1 percent.

III.3. Artificial intelligence and the Elaisian case

The aim of the analysis of this company is to verify the positive impact of intelligent technologies on a concrete business case. The decision to choose such firm is related to the elevated utilization of AI related technologies in the business value chain. In particular, Elaisian, has incorporated in its core business AI applications such as Machine

[196] Data from "Agrinnova" research by Wired, Ibm and Coldiretti, 2015. Retrived from: https://www.wired.it/partner/agrinnova/

learning technologies through which algorithms learn how to process data and provide more precise Predictive analysis.

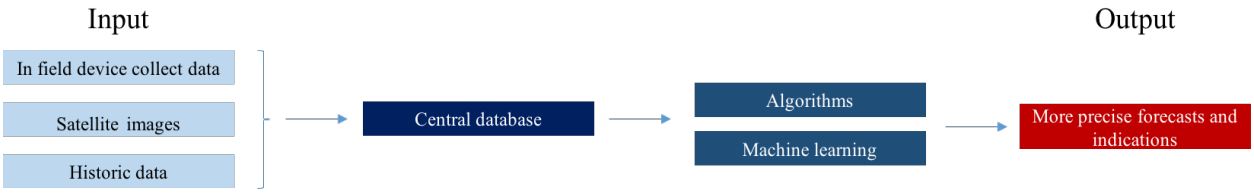


Figure 20

Input data are provided through external sources such as satellite images and historic data on the geographic area concerning weather trends. Furthermore, farm specific data come from in-field collection through a device installed directly in the ground. The device is a sort of computer which cover up to six hectares of field. Data are transmitted to the platform that processes them through algorithms based on agronomic studies.[197] The farmer has its own access to the company web platform, where he receives all the necessary information. Advices on the daily cultivation and alarm notifications for any diseases are provided based on real time observation.

Elaisian AI applications are two: Machine Learning and Predictive Analytics applied through algorithms to the huge amount of data stored in the company database. The reason why Elaisian is interested in adopting such technologies is because the company "*system is all based on data collection and processing. In this sense both machine learning and predictive analytics are fundamental."*

How important are artificial intelligent applications for Elaisian business?

We asked the CMO to select on a 1 to 4 scale, 1 meaning "not at all" a 4 meaning "very important, how essential is artificial intelligence, in particular machine learning, in his business and for which function? According to him, Machine learning technology is the core of the firm value. In particular, it is vital for Business intelligence and analytics functions; he selected rate 4 as the most important. *"This technology allows Elaisian to have a self-updating and more precise algorithms with reduction of personnel costs and maintenance."*

[197] Elaisian website: Services

Furthermore, he selected the rate 3 for Customer Service and Experience and Process automation.

"Through machine learning implementation all process is automated". For the function Marketing and Advertising, the rate was 1 but the plan is to enhance it in the future.

The benefit Elaisian hope to obtain through intelligent applications new ways to enhance automation of process and its digitalization. At the same time, AI is a precious asset in assisting and implementing new business strategies.

We asked if these applications are projected and realized in-house or purchased outside. Mr. Di Mambro said that "*while it is hard to find experts because they are few and contented by big tech giants, we aim to develop internally our expertise. Two reasons: it is cheaper and we can have more control on it since it can constitute competitive advantage."*

Further on, in our interview we have been talking about current AI trends on the market. Di Mambro believes that is in the Agriculture industry that new intelligent applications are impacting more. He confirmed the analysis we done about the biggest challenges for AI adoption by firms. It is a crucial question since Europe is lagging behind China and the United States for AI firm implementation. He told us that the main difficulty is finding available experts skilled in AI. This reflects the results of a survey by European Commission. To the question "which are the biggest roadblock to AI adoption by firms?" the 54 percent answered "lack of skilled people".[198]

This trend is confirmed in the interview: *"investing in such technologies requires specific talent and expertise, it is hard to find experts."*

Finally, Elaisian has already invested much in AI and will continue to enhance this trend due to the strategic importance for its business.

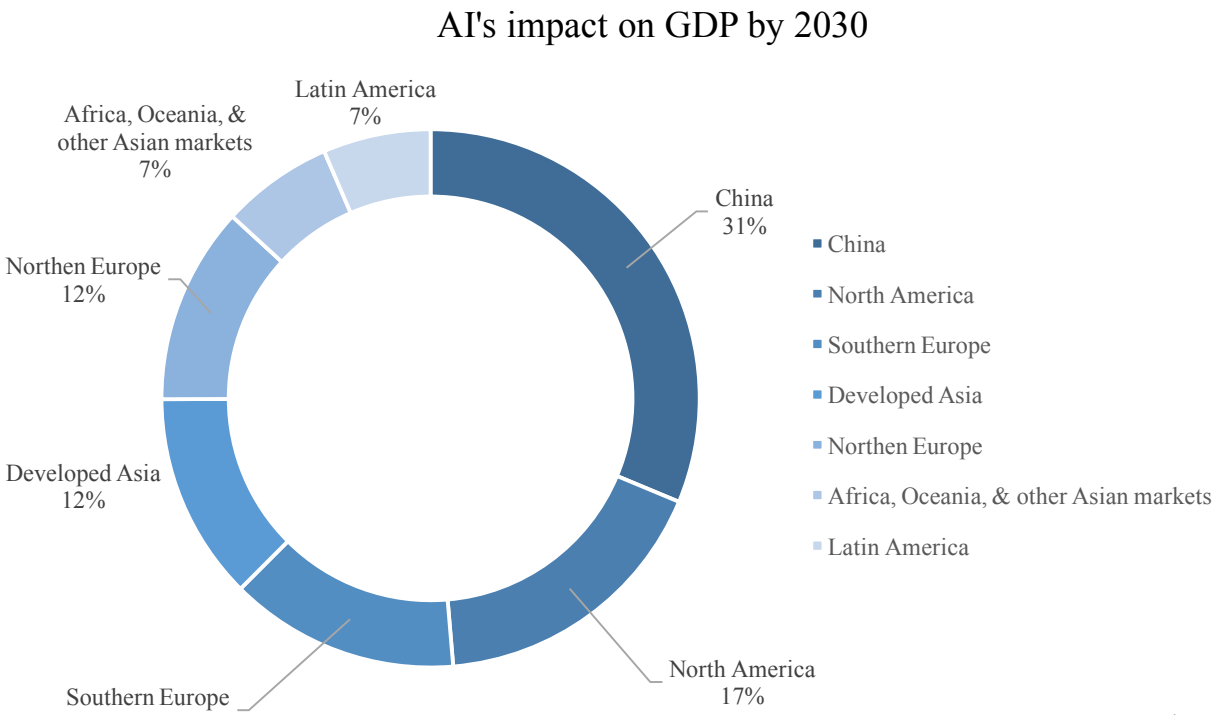
[198] European Commission, Europe's Digital Progress Report (2017). Human Capital: Digital Inclusion and Skills.

IV. Artificial intelligence: the global challenge

"Right now, AI is a two-horse race between China and the US"[199]

Anthony Mullen, Gartner, Director of research

$15.7 trillion, 14 percent of the world GDP, this is the value of economic benefit deriving from AI in 2030 according to last researches.[200] This number is equal to more than the sum of the today gross product of China and India. This is also the value of the AI revolution deriving from the increased productivity ($6.6 trillion) and the impact on the consumption side ($9.1 trillion). The stakes have the weight to completely redesign the global economic equilibrium. Many governments have settled a long-term strategy to gain the AI global leadership. In the last chapter, the analysis of AI was focused on the impact relative to the agents of the economy. In this section, there will be analyzed the impact on the geographic scale and the effects depending on the country.



Source: PwC Global Artificial Intelligence Study, 2017: PwC Global Artificial Intelligence Study, 2017

Figure 21

[199] James Vincent, 2017. China and the US are battling to become the world's first AI superpower. The Verge

[200] PwC, June 2017.

AI has a huge impact but benefits and downsides are distributed unevenly through the globe.

Each country, depending on its economic structure, the entrepreneurial culture, the work market and the complex of policies, absorbs the AI disruption in a different way.

While some industries, markets and individual businesses are more advanced in certain countries than others, AI is still at a very early point of development.[201] This means that, in the macroeconomic scale, developing countries may have the chance to overtake the most advanced economies. At a microeconomic point of view, startups have the possibility to hold a significant competitive advantage and take the market leadership, while the incumbents are under risk of collapse. According to a survey, more than 70 percent of business leaders believe that AI will be the business advantage of the future.[202]

Numbers of AI companies:

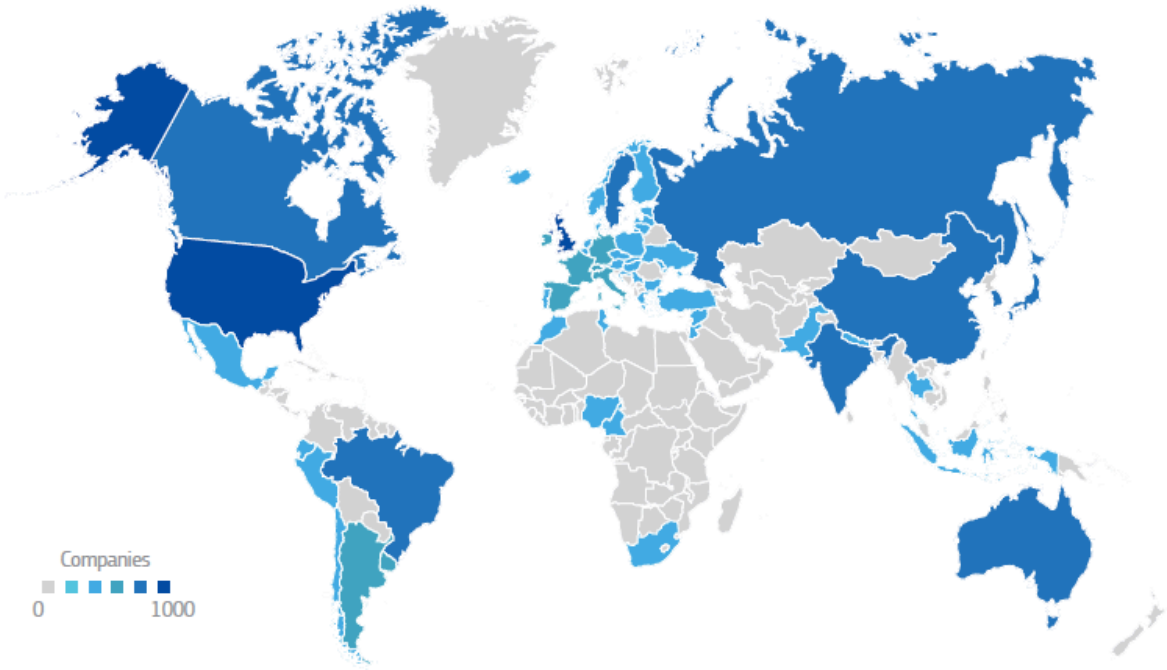
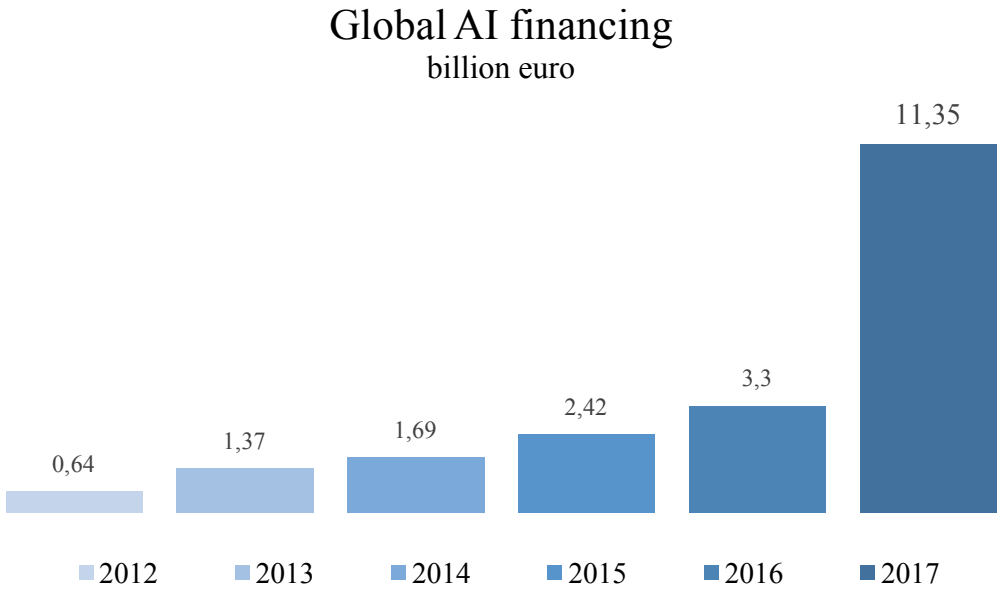


Figure 22

Source: White House, National Artificial Intelligence Research and Development Strategic Plan

[201] PwC, June 2017.
[202] PwC, December 2017.

According to the European Commission, the Asian countries are taking the lead of the AI wave.[203] China, Singapore, Japan, and South Korea have developed long-run strategies and allocated massive resources. In December 2017 the government of China announced a three-year strategic plan for 2020 with the target to realize the neural network mass production and the 10 percent goal of increased energy efficiency with an economic impact equal of 26.1 percent of GDP, which means $7 trillion.[204]



Source: Venture Scanner, Artificial Intelligence Start-up Highlights, Q4 2017

Figure 23

However, North America is expected to experience the fastest improvement in the next few years, even if with different strategies. 70 percent of the global economic impact of AI will be concentrated in North America and China.[205]

As shown in the graph, the United States and Canada are concentrated most of AI companies. Canada seeks to achieve AI excellence while in the United States is more focused on the long-term AI basic research with an emphasis on the private sector and minimum policy regulation intervention.[206] For what concerns Europe there is not still a

[203] EPSC Strategic Notes, EU Commission, 27 March 2018.
[204] MIT Technology Review, 15 December 2017.
[205] PwC, June 2017.
[206] Executive Office of the President, National Science and Technology Council Committee on Technology, 'Preparing for the Future of Artificial Intelligence', October 2016.

European Union framework. The United Kingdom and Finland have implemented detailed strategies, France is one step before with the activation of a task force, the mission Villani.[207]

Europe has to answer to internal and external AI challenges by pursuing two targets: First, building an enabling framework supporting investment in AI and, second, setting global AI quality standards.[208] The European Commission is willing to implement a continental approach in order to scale resources and emerge as a quality brand for AI.[209]

[207] Republique Française, January 2017. #FranceIA: the national artificial intelligence strategy is underway
[208] EPSC Strategic Notes, EU Commission, 27 March 2018.
[209] EPSC Strategic Notes, EU Commission, 27 March 2018.

IV.1. Where does Europe stand?

The AI European situation is extremely complex and fragmented while, at one level, there is a continental willingness to implement AI joining national forces, at a second level, there are different national governments that pursue individually AI strategies, usually in competition. However, currently, there is no a strategic plan at EU level. Until now European firms were not able to exploit the potential of digitization. If this is the trend it seems unlikely that Europe has the right energies to catch the AI wave of innovation that is already spreading in the world. The advent of AI innovation and the diffusion of its related technologies will have a deep impact on business, labor and institutions. Impact means great opportunities but also threats. While China and the United States are in advance, European firms risk being dragged out of the market in the early future through more innovative and efficient extra-continental competitors.

The resources invested by the European Commission are set into the Horizon 2020. This program provides investments for the period of time between 2014 and 2020 and it focuses on three key areas: robotics, AI-related applications, and skills enhancement. €2,6 billion are destined for AI related application as big data, health, transportation and emerging future trends.[210] Form the European Structural and Investment Funds are provided €27 billion on "skill development" out of which €2,3 billion are destined for digital skills.[211] Still, there is no an EU AI strategic plan and , it lacks a clear and shared vision on how to support the uptake of AI.

However, with the exception of some successful examples, the rate of adoption of AI technologies by European companies is still slow. The regulatory and academic environment that surrounds such companies are the main factors for developing an advanced AI continental system, but there are still labile interconnections. In this system, data are one of the main ingredients for AI to flourish. For what concerns China, availability of data is a strong advantage on the United States and Europe because of the

[210] European Commission, Digital Single market factsheet, April 2018.
[211] European Commission, Digital Single market factsheet, April 2018.

lack of privacy protection regulation, which is now advanced in Europe after the GDPR implementation. For example, while in China the willingness to share location data with their car manufacturer is roughly 93 percent, American people agree only for 72 percent compared to 65 percent of German customers.[212] Only the 4 percent of world data is stored in Europe while only 25 percent of large European enterprises and 10 of SMEs employ big data analysis system in their business in 2017.[213]

At the same time, small companies have significant difficulties in implementing AI technologies because of high investments required, lack of specialized staff and diffidence.
On average roughly less than 1 percent of the EU workforce is constituted by data scientists.[214]
In this environment, only a few big companies are able to raise high volumes of investments and implement AI business applications. Tech giants in Europe are ABB, Bosch, BMW, and Siemens that face rough competition of American and Chinese companies. There is a vivacious environment of small European tech companies and startups that are able to perform high excellence at global level, such as Skype and Deepmind.

However, these companies once they reach the success are usually acquired by non-European corporations. Europe is a land of conquest for non-European firms. This is true because, nevertheless the slow business adoption rate of AI technologies, academic and scientific research in Europe is still strong and globally appreciated. However, in Europe it results hard to convert promising invention into profitable innovations and exploit their economic potentiality.

The proof of that is the relative small number of globally successful digital companies developed in Europe in the last decade.[215] Moreover, only non-European tech companies

[212] Deloitte, 'The smart factory: responsive, adaptive, connected manufacturing', August 2017.
[213] European Commission, 'Europe's Digital Progress Report', 2017.
[214] Organisation for Economic Cooperation and Development, Data-Driven Innovation, 'Big Data for Growth and Well-Being, October 2015.
[215] McKinsey Global Institute, briefing note prepared for the EU Leaders Tallinn Digital Summit, '10 imperatives for Europe in the age of AI and automation', September 2017.

have established in Europe AI-hubs in order to drain the talented students from EU universities. For example, Facebook opened an AI laboratory in Paris. Europe is an incubator for other continents, producing skilled experts but unable to hold them and build a sizable international company able to compete globally.[216] European Commission set a long term strategy in order to create a positive framework for the investment enhancement in AI field as internal challenge. The external challenge is setting global AI quality standards.[217]

In this direction has been issued the proposal for the "European Strategy for Artificial Intelligence" based on four-dimension approach:

1. **Support** the creation of a favorable environment for development of AI technologies;
2. **Educate** in order to provide individuals of AI skills;
3. **Enforce** to implement policies directed to tackle AI biases and challenges;
4. **Steer** a human-centered approach.

Europe still needs an integrated and continental long-term artificial intelligence strategy. Today, EU still lack behind the China and the United States. Losing the global race for AI leadership will have harmful impact for European companies, workforce and political influence since the extent of such innovation.

IV.1.a. Support

Data, computational power and sophisticated algorithms are the key factors that lead the expansion of AI. In order to take the global leadership of the AI rush, leveraging on data is the starting step.[218]

"**Building a European Data Economy**" is the name of the European Commission initiative for the demolition of barriers to the access and the share of non-personal data

[216] Wired, 'Europe is leading the way in Artificial Intelligence and Machine Learning'. See http://www.wired.co.uk/article/deep-techeurope-hubs.
[217] European Commission, 'Legislative priorities for 2018-2019', 14 December 2017.
[218] AI Now Institute, 'AI Now Report', November 2017.

across the EU area.[219] While efforts have been made in order to foster the protection of personal data through the GDPR, on the other side is key enhance the collection and the free movement of them. The initiative includes the proposal for the development of the free flow of personal data which is under examination of the Council and the European parliament.[220] This is the issue of the creation of the "5th freedom for movement of non-personal data within the Single Market".[221]

The European Commission should work in order to pursue the creation of data commons platforms. The reason is that the data commons will stimulate the competition and help medium and small firms to compete with multinationals' data power.

The initiative is the "Industrial Data Spaces" is a platform aimed to enhance the exchange between European enterprises of data.

In order to support the strategic utilization of data, investments are required. European Commission has signed with fifteen EU member states an agreement for developing integrated advanced super-computer infrastructure in order to leverage and scale up efforts.[222] This agreement is part of the wider **Digital Single Market Strategy** which aims to enable a favorable regulatory framework for AI and unlock the access to investments.

Investments that are still lower than other extra-European countries. While for the period 2016-2020 the European Commission has invested €100 million per year, only in 2015 the United States government has invested €800 million while the only South Korea is investing with private companies €730 million.[223] At the same time, there is a lack of external investment in AI-research. In the 2016 European external investments were roughly from $3 billion to $4 billion that is nothing compared with $8 billion to $12 billion in Asia and $15 billion to $23 billion in North America.[224]

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[219] 'European Commission, Communication on Building a European Data Economy, January 2017.
[220] 'European Commission, 'Regulation on the Free Flow of non-personal Data', September 2017.
[221] Inria Saclay– Île-de-France Research Centre, 'Marc Schoenauer to work with Cédric Villani to define an AI strategy for France'. See https://www.inria.fr/en/centre/saclay/news/marc-schoenauer-to-workwith-
cedric-villani-to-define-an-ai-strategy-for-france.
[222] European Commission, 'EU Ministers commit to digitising Europewith high-performance computing power', March 2017.
[223] McKinsey Discussion Paper, 'Artificial Intelligence, the Next Digital Frontier?', 2017.
[224] McKinsey Global Institute "Digitization, AI, and the future of work: Imperatives for Europe", September, 2017.

Investments are still not enough even if Europe accounts the highest number of excellence AI research institution in the world. Such excellence is still not adequately connected with the texture of universities and AI labs. The United States and China both have *AI "ecosystems"*: clusters of AI entrepreneurs, financiers, and AI users. The United States and China have issued national strategic plans in the past 18 months with meaningful AI dimensions, in some cases supported by funding initiatives.

IV.1.b. Education

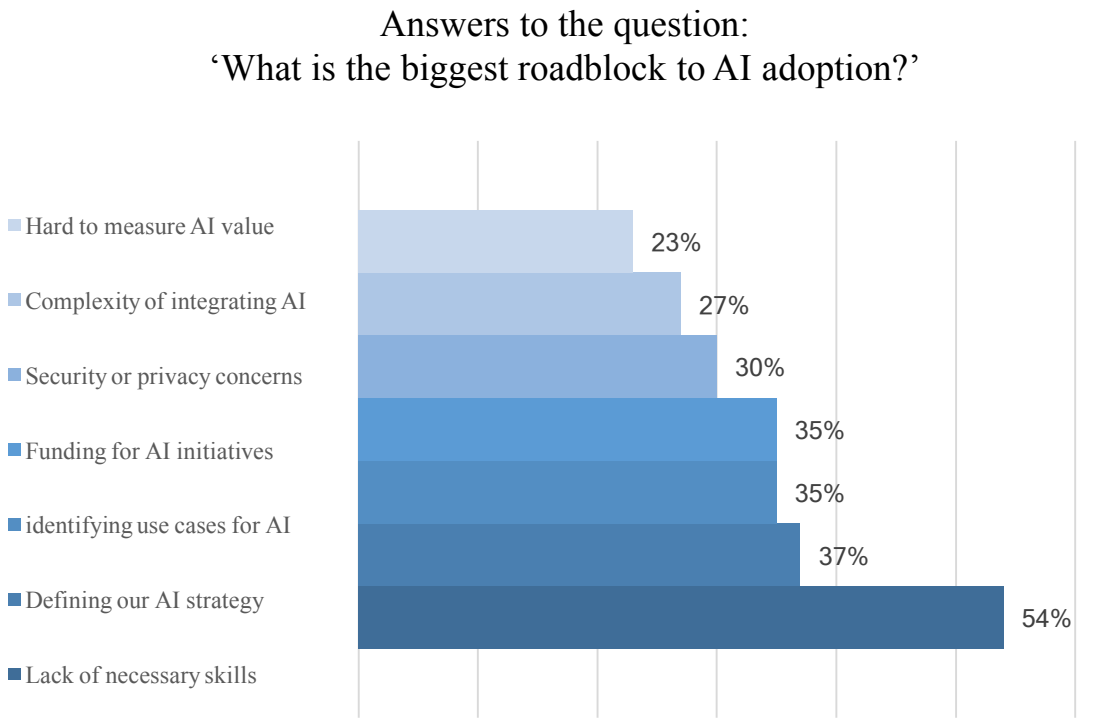


Figure 24

The results represented in the graph above indicate a strong need of AI-skilled labor force. The last researches esteem that today there are less than 10,000 people with the minimum skills required to develop serious AI research.[225]

[225] The New York Times, 'Tech giants are paying huge salaries for scarce AI talent'. See https://www.nytimes.com/2017/10/22/technology/artificial-intelligence-experts-salaries.html.

This is reflexed in the high wages that multinationals offer to the few experts available on the market. Mergers and acquisitions are today the main path towards the collection of AI experts. Nevertheless, the European Commission forecast that by 2020 there will be available up to 700,000 vacancies for AI experts.[226] On the contrary, the 37 percent of European workforce still lack of basic digital skills.[227]

40 percent of companies trying to recruit ICT specialists reported difficulties in filling vacancies. Form the European Structural and Investment Funds are provided €27 billion on "skill development" out of which €2,3 billion are destined for digital skills.[228]

IV.1.c. AI enforcement

The characteristics of the market have changed and policies and authorities need to develop and adapt to the current trend. The exceptionalism provided for online platforms and AI companies is going to vanish since they have reached huge dimension and exert strong influence on the market. For example, article 14 of e-Commerce European directive exempts online intermediaries from liabilities related to content they unwarily host on their platforms.[229] It is interesting observe that the date of that directive is 2000, more than 18 years ago. From 2000 many things have changed and such regulations are not suitable and updated for the current state of the economy and, especially, for what is going to happen with the AI revolution.

Beyond the General Data Protection Regulation, it is necessary discuss about the competitive environment which is key for preventing market distortion and biases. Implementing an efficient competition policy that enable market rewards distribution to the most innovative and efficient players is central. Adapting competition policy to the new innovative environment means also Antitrust enforcement since the market is going to concentrate into few digital players that control most of AI technologies and experts.

[226] European Commission, 'A New Skills Agenda for Europe', June 2016.
[227] European Commission, Europe's Digital Progress Report (2017). Human Capital: Digital Inclusion and Skills.
[228] "Artificial Intelligence for Europe", Digital Single market factsheet, April 2018.
[229] Directive 2000/31/EC of the European Parliament and of the Council of 8 June 2000 on certain legal aspects of information society services, in particular electronic commerce, in the Internal Market ('Directive on electronic commerce').

In this direction is necessary the implementation of merger control because is one of the main cause of market concentration.

Most of startup acquisition by big companies are below the notification turnover thresholds and, so, skip the control of market authorities.[230] This trend is going to reduce drastically the competition in the future since only few big companies hold the whole AI knowledge and tools.

IV.1.d. Steering a human-centered approach

The main challenge for Europe is to combine the development of AI without losing the its own cultural preferences and values. The European Commission Committee on AI has indicated the construction of a Pan-European long term strategic plan to steer AI with compatibility with European principles.[231] The direction is pursuing EU as quality brand of AI.

Essential is the constant monitoring of the evolution and diffusion of AI technologies while, at the same time, enforce quality standards in order to lessen biases and distortions. It is important steer a human-center approach while enhance AI diffusion. It may sound divergent but it is possible combine AI with human work by enhancing retraining and giving workers the skills to exploit and foster their tasks with new tools, in spite of being simply substituted by automation.

IV.1.e. European national AI strategic plans

The lack of a clear and shared AI strategic plan at European level, Member States are developing their own strategies.

This is the case of Strategy #FranceIA. The aim is to foster the creation of a **French** AI industrial hub and, at the same time, foster data protection, privacy and transparency. This is the case of Inria, the French National Institute for Research in Computer Science and Automation, that signed a partnership with Fujitsu which plans to invest €50 million for

[230] EPSC Strategic Notes, The Age of Artificial Intelligence, 2018. European Commission.
[231] EPSC Strategic Notes, The Age of Artificial Intelligence, 2018. European Commission.

AI and deep-learning research in France.[232] In the project universities and research institutes will join in order to create one of the first European AI ecosystem.

A more ambitious plan is the one developed by **Finland** that aims to become a global AI leader in the next decade. A focus group of experts was assembled in 2017 by the Minister of Economic Affairs, Mika Lintilä. The group set a plan eight key actions in order to improve AI at national level.[233] The **United Kingdom** has updated its AI strategy since the huge impact of such technology on the economy. Esteems suggest that the economic impact for the United Kingdom may be of roughly € 730 billion for 2030. The British government plans to invest £17,3 million in order to enhance robotics and AI technologies.[234] Furthermore, the government focused on the training and retraining sessions for update digital skills.

However, the most advanced steps have been made in **Germany** that, if on one side lacks of a national AI strategy, on the other side this is compensated by the concrete action of the private sector. In the state of state of Baden-Württemberg there is the first AI hub of Europe, the Cyber Valley. This is a concrete example of tech ecosystem implemented at regional level. Included are Amazon, Facebook, BMW and the University of Tübingen. Germany is specializing in the automated driving through the program Mobility 4.0 and the support of the German big car manufacturers.

[232] "Fujitsu to invest over 500 Million Euros to support Digital Transformation in France" Fujitsu Website, 2017,

[233] "USA-China-EU plans for AI: where do we stand?", European Commission, Digital Transformation Monitor January 2018

[234] Press Release of the UK Department for Digital, Culture, Media & Sport, 2017, "£17million boost for the UK's booming artificial intelligence sector"

IV.2. China and the United States: the global race for AI supremacy

"AI will become the main driving force for China's industrial upgrading and economic transformation"[235]

China's State Council Notice on the Issuance of the Next Generation AI Development Plan

The Chinese government has taken seriously the AI global race and it seeks to catch in for 2030 the world AI leadership. Today, North America and, in particular, the United States toughly hold the AI primate since the strength of its global leaders such as Google, Amazon, Apple, Microsoft and Facebook. However, there is a shocking amount of research indicating the gap is shrinking.[236]

"It's pretty simple. By 2020, they will have caught up. By 2025, they will be better than us. By 2030, they will dominate the industries of AI" said Eric Schmidt, CEO of Google's Alphabet company and the chairman of the Pentagon's Defense Innovation Board, commenting the Chinese government AI plan. Data are clear and confirm these words. The World Bank predicts China will count for $14 trillion GDP predicted for 2019. In the same year China will counts the 35,2 percent of the global economic growth, the double of the United States GDP growth, 18,9 percent, more than 4 times the Eurozone one, 7,9 percent.[237]

According to PricewaterhouseCoopers projections the AI development will impact global economy with an increase of $15,7 trillion, $7 trillion of that are part of Chinese economy.[238]

[235] A Next Generation Artificial Intelligence Development Plan, China's State Council Notice, July 20, 2017
https://www.newamerica.org/documents/1959/translation-fulltext-8.1.17.pdf
[236] "China set to leapfrog US in the AI race" Tristan Greene, The Next Web, August 2018.
[237] Data from The World Bank, 2018. Data are referred to Real GDP growth.
[238] "Sizing the prize What's the real value of AI for your business and how can you capitalise?", PricewaterhouseCoopers, 2018.

China dominates the world's AI startup funding with 48 percent of total, while the United States only 38 percent.[239]
The Chinese tech giant Alibaba has planned to invest $15 billion in international research labs while government officials from Beijing are mobilized AI research and venture funds.

China has three "natural" advantages on the United States:

1. Largest population on Earth, 1.4 billion. This provide wider amount of available data and the opportunity for companies to scale quickly.
2. Strong government influence.
3. Loose approach to digital regulation and lack of privacy protection. This allows companies to experiment without regulatory barriers.

In addition, according to Kai-Fu Lee, venture capitalist, technology executive, writer, and AI expert, China has four competitive advantages in respect to other countries:

1. Abundant data;
2. Hungry entrepreneurs empowered by new tools;
3. Growing AI expertise;
4. Mass government funding and support.

IV.2.a. Abundant data availability

Given the largest population on the planet and also one of the less protective privacy regulation, China has a strong advantage on one of the main AI key factors. At the same time, it is not an advantage that western countries are able to duplicate since the people

[239] "China overtakes US in AI startup funding with a focus on facial recognition and chips", James Vincent, The Verge, Feb 2018.
https://www.theverge.com/2018/2/22/17039696/china-us-ai-funding-startup-comparison

aversion to disclose their personal data and the enforcement of regulation such as the GDPR.

The Chinese WeChat platform has over 1 billion active users, that is way larger than the Europe population combined with the United States. Roughly 83 percent of all smartphone users in China do use WeChat.[240] WeChat's penetration of smartphone users states up to 93 percent only in China's Tier 1 cities.[241]

The Chinese e-commerce is almost the double of the United States amount.[242] Mobile payment data in the United States are roughly $122 billion in 2016, in the same year the amount in China was over $9 trillion.[243]

Furthermore, Chinese data are not spread and fragmented but few technologic giants like Tencent hold the totality of available data. The power of Beijing is not only inside its borders but it is growing abroad. The diffusion of Chinese bike sharing as Ofo or Mobike are providing to huge amount of data about people habits and shopping routine.

IV.2.b. Entrepreneurial AI environment

"The velocity of work is much faster in China than in most of Silicon Valley. When you spot a business opportunity in China, the window of time you have to respond is very short," declared Brain Andrew Ng, one of Google's founders.[244]

While the Chinese AI giants (Baidu, Alibaba, and Tencent) are imposing their influence on Asia, there is an exploding number of startups and entrepreneurs that through the "copycat" strategy have learned the most advanced tech skills.

SenseTime Chinese startup specialized in computer vision, whose technology is used also by police to spot suspects with the help of surveillance camera footage, in the 2018 was the most valuable startup in the world and is imposing as the leader in this specific AI field. Its value is esteemed over $4.5 billion. China is leading start-ups, which include a wide range of everything from fintech and drone companies to vegetable-sources for

[240] "WeChat has hit 1 billion monthly active users" Rayna Hollander, Business Insider, March 2018.
[241] "Questions over pace of growth as WeChat nears 1bn users", Louise Lucas, August 2017.
[242]
[243] Source: The Wall Street Journal
[244] "China Is Quickly Becoming an AI Superpower", Peter H. Diamandis, Singularity Hub, August 2018.

restaurants, created one of the world's biggest pool of unlisted companies with billion-dollar valuations.[245]

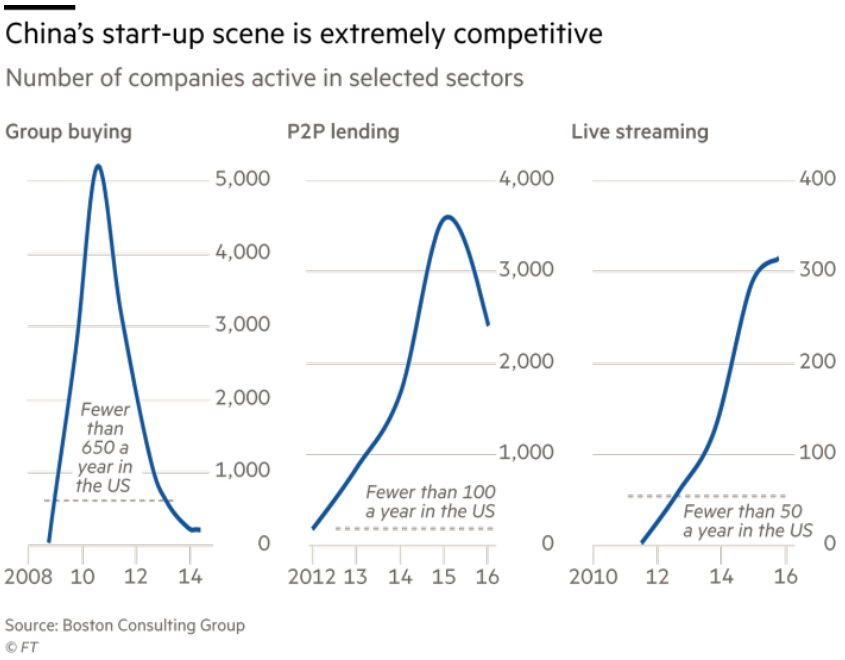


Figure 25

The government of Beijing declared the country was home to 168 unicorns, companies valued more than $1 billion, worth a total $628 billion.[246]

What differs Chinese startups from the western ones is also the strategy. Usually, Chinese firms offer services for free or products with high discounts. Ken Xu, managing partner at venture capital firm Gobi, said "it's the China playbook. Get very big and make money later."[247]

While the power of computers and the huge amount of data satiate the voracious hunger of its sophisticated algorithms, Chinese companies have another key element: the growing number of skilled people. However, for now the gap is still huge. China does not have the same vibrant and vivacious AI ecosystem as the United States Silicon Valley, which is large, diverse and diffused between universities, private companies and research labs. For China it is hard to replicate the same AI ecosystem. Furthermore, the same verve is in the M&A campaigns of the American tech giants that is way higher than the Chinese tech firms.

[245] "Boom time for China's billion-dollar start-ups", Louise Lucas, The Financial Times, April 2018.
[246] "China's Ant Financial shows cashless is king", Don Weinland, The Financial Times, April 2018.
[247] "China's Ant Financial shows cashless is king", Don Weinland, The Financial Times, April 2018.

IV.2.c. Growing AI expertise

Last year, in the AAAI conference, held in San Francisco on AI, were published an equal number of researches on AI coming from the United States and China. This is surprising since the advent of Chinese expertise on AI research is relatively recent in contrast with the United States. Only in 2015 roughly 10.000 papers on AI were published by Chinese researchers; a number that is larger than the combination of papers published by the United Kingdom, India, Germany, and Japan. Such evidence suggests that the gap is shrinking and Chinese skilled experts are worldwide recognized. At the same time, on different side, Chinese tech giant firms are investing in partnership with University in order to create a favorable AI ecosystem and ensure fresh minds and ideas to the companies.

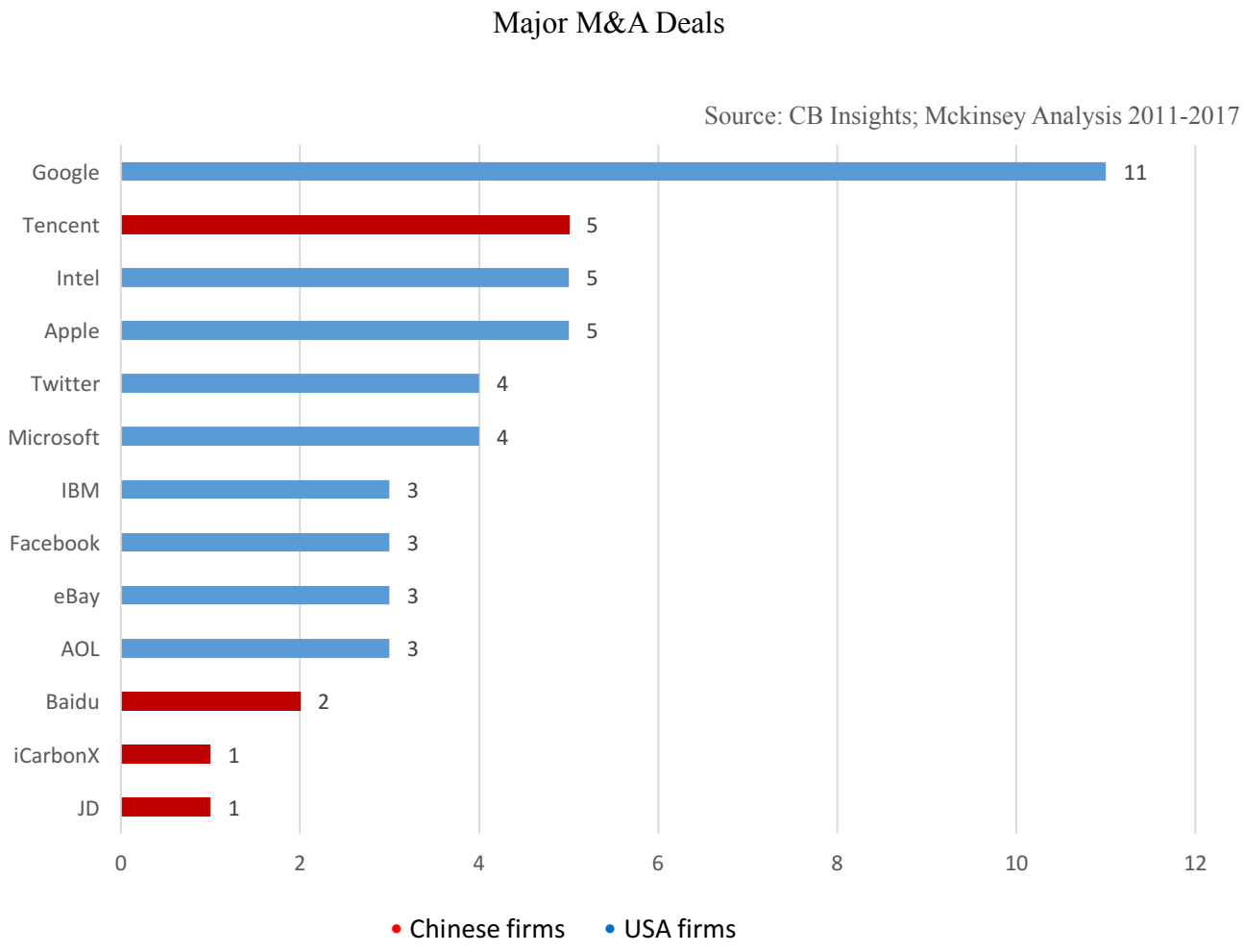
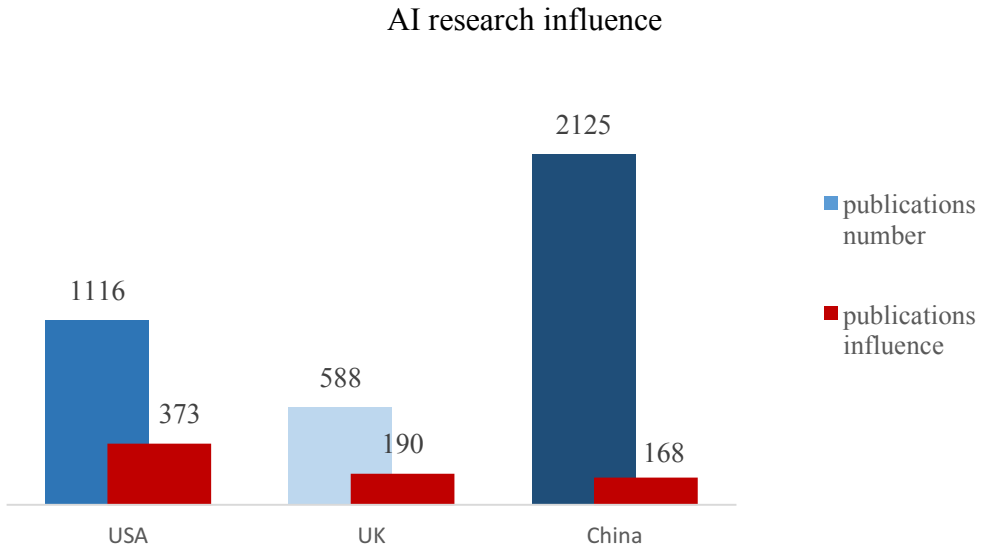


Figure 26

Indeed, the greatest efforts behind the advancements in Chinese AI come from private sector tech firms. Tencent offers scholarship to Hong Kong of Science and Technology students implementing a AI research lab. The ecosystem is sponsored and implemented with the vast support of the government. The Chinese government is funding recruitment and talent acquisition programs such as the "Thousand Talents" program. Beijing city planned the development of an AI park, Xinhua, with an investment of $2 billion that will host up to 400 AI companies and boost AI R&D.[248] However, while it is true that China produces the widest number of research, it is also true that US and UK research remains more influential. According to the H-index, a system that ranks the productivity of scholars and the impact and citations of their publications, the United States publications



Data source: SCImago Journal Rank 2015

Figure 27

are roughly the half of the Chinese ones but the former have almost double influence than the latter. However, the Chinese research is increasing the number of publications and in the early future such results may be extremely different.

[Table 32]

[248] "Beijing to build $2 billion AI research park: Xinhua" Cate Cadell, Reuters, January 2018.

IV.2.d. The government and AI

Air Force General Vera Linn "Dash" Jamieson, deputy chief of staff for intelligence, surveillance and reconnaissance on the Air Staff at the Pentagon, declared about Chinese public investment in AI that "the total spending on artificial intelligence systems in China in 2017 was $12 billion. We also estimate that it will grow to at least $70 billion by 2020."[249]

The China's State Council issued a document in 2017 called "New Generation Artificial Intelligence Development Plan" (新一代人工智能发展规划) where the Beijing government sets an ambitious strategy to become the world leader in AI by 2030 and the purpose of making the national industry worth 1 trillion yuan ($147,7 billion).[250]

The main core of this strategy is the "intelligentization" (智能化) of the economy, the public administration, and the military.[251]

The State Council declares that AI will be "the main driving force for China's industrial upgrading and economic transformation".

The strategy is divided into three steps:

- "By 2020, the overall technology and application of AI will be in step with globally advanced levels, the AI industry will have become a new important economic growth point."[252] China will achieve new generation of AI technology, implemented in devices and basic software. In this phase the government will develop standards, policies and ethics. China will "entrance into the ranks of innovative nations".[253]
- For year 2025 China expects to reach the "major breakthrough" and "industrial upgrading and economic transformation".[254] The paper talks about integrating AI in the basic state's functions as defense and health.

[249] Oriana Pawlyk, July 2018.
[250] Arjun Kharpal, CNBC, 21 July 2017.
[251] Graham Webster, Rogier Creemers, Paul Triolo, and Elsa Kania, New America, August 2017.
[252] State Council, July 2017. 新一代人工智能发展规划 - A Next Generation Artificial Intelligence Development Plan
[253] State Council, July 2017.
[254] State Council, July 2017.

- By 2030 “China’s AI theories, technologies, and applications should achieve world leading levels, making China the world’s primary AI innovation center”.[255]

In this document the Chinese government recognizes that the majority of AI investments and results come from the private sector and, at the same time, that there is a wide technologic gap between China and the other economies.

A proof of the width of this technological divide is in the abroad expertise aggressive recruiting and acquisition campaigns undertaken by the Chinese tech giants. Until now China has imported technology from abroad, by the next decades, seeks to pursue “indigenous innovation”. The plan is focused on reducing this gap and ensuring the “safe, reliable, and controllable” AI development while minimizing its risks.[256] thus, the main tool to close such gap is flooding the market with public AI specific funds.

Finally, the global race to AI has severe geopolitical consequences since such technology has, over the economic and civil implications, huge impact on military field. In 2017 the Chinese leadership has created the “Central Commission for Integrated Military and Civilian Development” under the direct control of the President Xi Jinping in order to pursue the defense objective (国家安全).[257] According to the director of the Central Military Commission’s Science and Technology Commission, Liu Gouzhi, China has planned to integrate civil and military developments in AI field through the “shared construction, shared enjoyment, and shared use” (共建 共享 共用).[258]

Beyond the opportunities and positive effects of AI implementation, there are obscure downsides. Chinese government is planning to establish by 2020 a “cybernetic mechanism of behavioural control, where individuals and organizations are monitored in order to automatically confront them with the consequences of their actions”.[259] The advances in AI technologies will so enhance the regime control and stability over the population, while it seems materializing in China a sort of dystopic-futuristic scenario.

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[255] Ibidem.

[256] “China’s Plan to ‘Lead’ in AI: Purpose, Prospects, and Problems”, Graham Webster, Rogier Creemers, Paul Triolo, and Elsa Kania, New America, August 2017.

[257] Helène Lavoix , « When artificial intelligence will power geopolitics, Presenting AI », The Red Team Society, Nov 29, 2017.

[258] Elsa Kania, « Beyond The Committee on Foreign Investment in the Unites States (CFIUS) : The strategic challenge of China’s rise in artificial intelligence », Yale Law School, Paul Tsai China Center, June 20, 2017

[259] Creemers, Rogier, “China’s Social Credit System: An evolving Practice of Control”

IV.2.d. The future AI leadership

In conclusion, the future of AI will not be only determined by the race for big data, but also by the competition for talents and expertise, a field where the attractiveness of China remains still unclear.[260] The gap between China and the United States is still wide, even if, in the last few years the situation has changed. This gap is shrinking, Chinese tech giants are investing more funds in AI internal research and in talent acquisition through an aggressive activity of mergers and acquisition all around the globe, supported by central government funds. At the same time, the Beijing government aims to become by 2030 the AI global leader considering such technology as the main factor for the economic growth and geopolitical power.

On the other side of Pacific Ocean, the United States AI ecosystem is the most vibrant AI environment in the world. American tech giants lead the AI research and development. Companies like Google, Amazon or Apple are the most diffused on the globe and, even if the competitiveness Asiatic firms is growing, they inject billions of dollars in AI research in many more diversified and advanced fields than their rivals. What is certain is that the speed of AI development is strongly increasing led, not only by private companies but, also by national governments.

At the same time, Europe is lagging behind. While there is still not a continental AI strategy and a strong commitment to enhance and invest in AI, some Member State governments have developed their own national strategies. Europe has excellence research lab and expertise while the private sector is still slow in adopting AI technologies. Single member states, alone, have several natural disadvantages in order to compete with China and the United States: they cannot count on the same amount of data, AI adoption by private sector is still low and, alone they cannot scale up resources at the same level.

Thus, single national strategies are not competitive with the strength and the dimension of the two world largest economies and it is necessary an integrated European AI strategy.

[260]"China protectionsim creates tech billionaires who protect Xi", Banjo, Shelly, Bloomberg, 6 March 2018

On the other side, the China's ambitions are concrete and the amount of funds for their enhancement are huge. However, the outcomes will depend on how long Chinese economy and private sector growth will be constant and sustained until 2030.

In the coming years, the key for the AI global race will be the ability of firms and governments, not only to invest but, also, to create collaboration and strategic agreements in order to leverage resources and exploit specializations.

What is certain is that, in the next decade, the global race for AI supremacy will not only deeply impact the economy but also the geopolitical weights on nations.

Towards a new economic paradigm

The artificial intelligence diffusion will completely change the economy, its impact will be global and diffused. We are talking about an innovation with an unseen degree of disruption that will shock the economic structure, the own nature of work and the relationship between humans and machines. Computers are always smarter, their artificial mind is developing cognitive abilities and, in many fields already outperforms humans. The progress in the artificial intelligence science made incredible advancements in the last decade. In the first part of this work we investigated which are the main drivers of such sustained improvement. We understood that this was made possible by the availability of immense amount of data which fed the voracious appetite of more advanced algorithms. Machine learning techniques enabled them to improve and evolves autonomously, with no need for human intervention. Actually, they are so complex that same engineers that programmed them are not even able to understand them anymore. Moreover, they are run by powerful computing power which is subject to the Moore law and grows at an exponential pace. It is clear by analyzing these trends that intelligent machines will soon come into our daily lives. Many intelligent applications have been already implemented and began to shake entire industries.

Individuating which are these applications, these industries and evaluating the extent of their disruption was one of the aims of the second part of this work. Firstly, evidence shows that the adoption and integration into the core business of intelligent technologic tools is a source of competitive advantage. The strategic relevance of artificial intelligence is demonstrated by the huge amount of investments flowing in this direction. Esteems indicate that only in 2016, private tech giants alone spent from $20 to $30 billion in AI, while machine learning gathered the largest amount of funds since considered enabling technology.[261] From our examination it is clear that the vast majority of financing efforts in intelligent technologies come from the biggest global digital players such as, for example, Google, Amazon, Apple but also Chinese Alibaba or Tencent. Data show that roughly the 90 percent of their total AI investment is aimed for R&D efforts

[261] McKinsey, (June 2017).

through internal research and by creating external partnerships with universities and labs. The left part is used for M&A through which tech giants are draining competencies and skills from the market by absorbing small innovative startups and hiring expertise; this phenomenon is known as "aqui-hiring".

Despite of this, competition is going to grow: in the last years also investment funds and venture capitals are joining the race for the new technology. In 2016, from $6 to $9 billion investments in AI were provided from startups, three times more than 2013.[262] This is a symptom that intelligent technologies promise to create and are actually generating new opportunities. Thus, we decided to study a concrete business case of successful AI implementation through the story of the Italian start-up Elaisian.

The company developed the first ag-tech service in the world that prevent olive-trees diseases. Thanks to a system of algorithms, based on an agronomics database, the system enables disease prevention and cultivation processes optimization. Complex algorithms run by artificial intelligence provide continuous monitoring of field conditions and suggestions. In the numerous interviews with the CMO and co-founder, we demonstrate that intelligent technologies create concrete benefits and can be developed also by small firms. In particular, they drop significantly operative costs and reduce environmental impact. Moreover, machine learning, implemented in the company core business, enables algorithms to learn and refine their work autonomously without human intervention. This optimizes the process while guaranteeing precision and rapidity.

At the same time, the analysis of the Ag-tech market suggested further considerations on the adoption rate of AI through enterprises.

Thus, we discovered that while firms' expectations on this innovation are high, the rate of intelligent tools diffusion is still low outside the tech industry. Only a few big companies control and benefit of AI progress, since high level of investments are required, and there is a lack of expertise available on the market. Hence, we can prospect two future scenarios: big digital players will absorb smaller firms, or AI will create new opportunities enabling the growth of new enterprises and increased competition.

[262] McKinsey, June 2017.

Today, we are still not able to evaluate with enough reliability the indirect future effects of intelligent technologies due to the still early stage of AI development and the uncertainty of related spillover effects. Effects that may be positive but may also create critical challenges.

Workforce needs to be reskilled in order to use new technologies rather than be substituted with them. AI-driven automation has already started to disrupt workplaces, changing the types of available jobs, the skills required for workers and the nature of work. This is the second main issue this study is focused on.

We found out that, firstly, automation and AI do not take jobs, but tasks and competencies which are part of a job position. The degree which those specific tasks and competencies are automated does cause the total or partial absorption of a human job by machines. In order to understand the impact of automation and AI technologies on human work, we made a distinction between work tasks.

We discovered that the more a task is routine or manual the more is likely to be automated. In addition, data show that, usually, the most vulnerable by automation jobs are also those ones related to a lower income work position. The analysis proves that there is a negative correlation between the wage/education and the probability of automation. Still, the trend reveals a polarization of the job market towards higher wages weeping out the middle and lower income jobs, in the short-term. This is evidence place into the automation risk area also those occupations that were believed as a safety net for lower income jobs.

This phenomenon is known as "skill-biased technological change".[263] The majority of benefits and economic value created by new technologies is going to be distributed to the higher income and skilled workers, which represents the minority of the population.

In addition, some experts believe that the skill-biased change is only an initial step towards a more enhanced inequality. The actual declining trend of wages in front of the increase of productivity is creating a radical transformation in the distribution of economic benefits: the majority of economic value, created by new technologies, is going to be distributed to the capital holders rather than the workers, the vast part of the population. This trend is defined as "superstar-biased technological change" and the effects are even more enhanced with a "winner take all" logic.[264] If this dynamic is going

[263] Frey, C. B. & Osborne, M. A. (2013).
[264] Brynjolfsson, E. & McAfee, A. (2014).

to occur on large scale, a diffused drop in wages may lead to the collapse of demand and the consequent breakdown of the entire economy. Obviously, this is an enhanced scenario that does not necessarily has to happen. For sure, the extent of AI disruption is wide and its impact has the potential to deeply shake the economy and way of allocating resources. While the direct effects of automation on short-run are strongly disruptive, it is hard to visualize what is going to happen later in long-run. It is extremely complex evaluate what are the future offsetting effects of automation and, how the increased productivity will create new opportunities or entire new markets.

Anyway, the introduction of new technologies and automation does displace jobs in the short-run but, in the long run, it creates completely new types of work or it shifts jobs to other adjacent markets. New workforce will be always more integrated with robots and machines since automation for most of the cases will be only partial. We found out that according to OECD only 9 percent of workers are under risk of total automation.[265]

The same nature of work will change and evolve. The core issue of the AI-driven technological change is to deal with the ability of the labor force to extract benefit from the increased productivity derived.

Definitely, technologic innovation will create benefits but, this growth will not be costless and will be accompanied by structural changes in the economy, and deep transformations in the skills that workers need to succeed in the economy of tomorrow.

Thus, the conclusion we achieved, is that the soaring inequality is not a direct result of the technologic innovation, but the effect of the actual economic environment that is skewed designed. Its distorted evolution enhances biases and dysfunctions. This is happening because the current economic model is obsolete and it is not suitable for the emerging disruptive technology. While technology is evolving, as never before, it is necessary that also the economic model evolve or at least adapt to the new scenario. We cannot manage the intensity of such deep technologic impact without reshaping our economic paradigm. Thus, the issue is what is the role that institutions, policy maker and regulatory agents have in this new scenario.

Providing an answer for such issue is the third point of this research. We explained and analyzed the main public policies and institutional intervention proposed in the last years.

[265] Arntz, M. Gregory, T. & Zierahn, U. (2016). OECD.

The first consideration we extracted from the experts and economist is that new technologic revolution driven by AI requires deep changes in the nature of work and the organization of our society. Common opinion claims the necessity of policy intervention in order to help those who will be disadvantaged and displaced by such changes and to ensure that huge benefits created by AI are accessible to everyone and developed in the best way. Intervention by the government should be addressed not to stop the diffusion of innovation but to unlock its potential while minimizing its disruptive effects.

One of the most effective strategies is enhancing the diffusion of new compatible skills for enabling people to control new technologies. This strategy may be enhanced by creating local ecosystems among enterprises, universities, and research.

In order to alleviate the disruptive effects of AI-driven automation and enhanced inequality, governments may implement policies of social security aid and income redistribution through capital taxation. Pursuing a social security aid for displaced workers and job seekers is a strategy directed to allow a more efficient job placement and lift aggregate demand. The risk is that a massive number of layoffs may transmit into wider economic recession. The crucial issue of such policies is to help those displaced by automation but, at the same time, do not disincentive the research of other occupation. I believe this strategy is a more viable alternative to the Universal Basic Income (UBI). This research could not ignore to evaluate this recurrent issue in the debate around AI. UBI essentially provides a basic income to the whole population to guarantee a wage above the poverty level. It would be implemented as an alternative to the welfare state, so funded with the same resources, and it would reduce costs related to bureaucracy. It would be economically efficient because refunded through VAT. However, UBI can create a strong disincentive to work, it requires the complete redesign of the security system and welfare mechanisms while it could cause increasing inflation. Critics say that the State should foster training and skills helping people in finding the best job without creating a policy planned to alienate people from work.

In conclusion, there is a vibrant debate about the issue of taxing robots. Bill Gates was one of the first to propose taxes on robots because they actually substitute employees.[266] Related funds would be used to promote social security policies and training programs. We believe in the value of this strategy but also in its impossible implementation. The

[266] K. J. Delaney, (February, 2017).

risk of the enforcement of robot tax would cause companies simply to move towards other countries.

It is the global competition the final focus on this research. With an esteemed value of $15.7 trillion, 14 percent of the world GDP, of economic benefit within 2030, artificial intelligence will redesign completely the economic equilibrium in the next decades. In the last chapter, the analysis was aimed to assess the state of the art of the global race for AI supremacy. The AI European situation is extremely complex and fragmented. While there is still not a continental AI strategy and a strong commitment to enhance and invest in AI, some Member State governments have developed their own national strategies. Europe has excellence research labs and expertise, while enterprises are still slow in adopting AI technologies. Single member states, alone, have several natural disadvantages in order to compete with China and the United States: they cannot count on the same amount of data and, alone they cannot scale up resources at the same level. Thus, single national strategies are not competitive with the strength and the dimension of the two world's largest economies and it is necessary an integrated European AI strategy.

The evidence is clear, today the United States has the most advanced and diffused digital companies in the world while they are leader the AI development. There is a wide gap between China and the United States, even if, in the last few years, the situation has changed. This digital divide is shrinking, Chinese tech giants are investing more funds in AI internal research and in talent acquisition through an aggressive activity of mergers and acquisition all around the globe supported by central government funds. The Beijing government aims to become by 2030 the AI global leader considering such technology as the main factor for the economic growth and geopolitical power. China's ambitions are concrete and the amount of funds for their enhancement are huge. However, the outcomes will depend on how long the Chinese economy and private sector growth will be constant and sustained until 2030.

In the coming years, the key for the AI global race will be the ability of firms and governments, not only to invest but, also, to create collaboration and strategic agreements in order to leverage resources and exploit specializations.

What is certain is that, in the next decade, the global race for AI supremacy will not only deeply impact the economy but also the geopolitical weights on nations.

Towards a new economic paradigm.

New challenges require new tools and innovative approaches. From this research, it emerges that AI innovation will have a disruptive impact on the whole economic structure. In order to explain and, thus, manage the extent of so deep changes we need to develop new approaches and a new paradigm. Conventional economic theories are not suitable anymore with new disruptive technologies. This is clear from the evidence. Enterprises have to develop new business models and learn how to integrate intelligent technologies. Governments need to study to adopt new policies to contemporary challenges while workforce needs to acquire new skills in order to unlock and manage the potential of new technologies rather than compete with them.
We cannot try to prevent innovation to occur but we have to learn how to manage it. Stephen Hawking said that 'Artificial Intelligence could be the biggest event in the history of our civilization. Or the worst. We just don't know.' The outcome will depend on the capacity of our economy to adapt to the changes and we need new tools. The stakes are high, but so are the opportunities.

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Attachments

Elaisian Business Case Interview with CMO Giovanni Di Mambro
We discussed with the CMO in different occasions. Below there are the questions and the answers relevant for our purpose. There are open questions and multiple choices options. In this case selected choices are underlined and bold.

1. **Are you the first mover in this sector? Is there any competition? If yes, are you the only company using AI?**

   The Sector is the precision agriculture. Elaisian is the first company which specialized on olive oil culture. For example, we guarantee water savings which consists in the majority of costs while the main core is on detecting tree illness. Our competitors focus on other kind of agriculture. For example, in Italy there is Revotree which is specialized only water savings. Arable in the USA market on wheat and corn; they use both ML technologies.

2. **What kind of AI application?**
   Through ML algorithms learn how to process data and provide more precise forecasts. Data on weather historic records of regions and cities. Purchased from external firms. Algorithms refine real time data.

3. **How essential is AI/ML in your business and for which function?**
   (On a 1 to 4 scale 1 meaning "not at all" a 4 meaning “very important"),
   a. Customer Service / Experience: 3
   b. Cybersecurity: 1
   c. Finance: 1
   d. Business Intelligence and Analytics: 4
   e. Marketing / Advertising: *today 1 but we plan to increase it.*
   f. Human Resources / Recruiting: 1
   g. Process Automation: 3

We utilize weather stations, satellite images and agronomics data. With them we constituted a database where algorithms make predictions and surveillance. The process is automated through ML while costs are reduced since there is no need of employ people.

4. **How much do you think your company will invest in AI / ML in the following business application areas in the next years?** *Already done much, will do more because AI constitutes the core business.*

5. **What would you say is the main reason that more companies are not adopting AI or ML into more of their core business processes?** (pick one)

    a. Most of the applications are still experimental and are not capable of substantial ROI
    b. The tech probably works, but there is not enough availability of useful case studies / precedents of successful
    c. use
    d. <u>Investing in AI / ML requires specific talent and expertise that our company doesn't currently have</u> → *it is hard to find experts.*
    e. Investing in AI / ML requires substantial financial commitments that our company isn't able to make at this time
    f. Other _____

6. **To what extent is your company currently using AI?**
    a. We are currently experimenting with AI (i.e., to validate its potential in products and services, evaluate use cases, etc.).
    b. We are developing prototype and proof-of-concept applications.
    c. <u>We now have AI applications deployed and in production.</u>
    d. We expect to have AI applications in production within the next 12-24 months.
    e. Do not know

7. **What benefits does your company hope to obtain from using AI?** (Please select all that apply.)
    a. Improved productivity and business efficiency
    b. <u>Providing new ways of automating business processes</u>
    c. Enabling new business models and lines of business (LOBs)
    d. Reduction of risks
    e. Augmenting human skills for better employee performance
    f. <u>Accelerating digital transformation efforts</u>
    g. <u>Assisting and improving business strategies</u>
    h. <u>Better customer experience</u>
    i. Enhanced agility for the organization and ability to respond to changing business conditions
    j. Increased competitiveness, i.e., ability to recognize and respond to threats
    k. Ability to recruit better employees
    l. Enhanced collaboration/team management
    m. Don't know
    n. Other (please briefly describe):

8. **Which AI technologies is your company interested in adopting? Why?** (Please select all that apply)
    a. <u>Machine learning (ML), i.e., neural networks</u>
    b. Natural Language Processing (NLP)
    c. Speech recognition
    d. Conversational computing systems
    e. Cognitive systems
    f. <u>Predictive analytics</u>
    g. Deep learning
    h. Intelligent virtual assistants and smart chatbots
    i. Computer vision and imaging systems
    j. Autonomous vehicles
    k. Machine translation systems, i.e., human language translation
    l. Robotics
    m. Rule-based and knowledge-based systems

9. **Why are you interested in adopting such technologies?**
   Our system is all based on data collection and processing. In this sense both machine learning and predictive analytics are fundamental.

10. **In which industries and domains do you see AI having its most significant impact?**
    a. **Agriculture**
    b. Automotive
    c. Banking and financial services
    d. Biotech
    e. Digital rights management
    f. Energy production
    g. Finance and Accounting
    h. Government
    i. Healthcare
    j. Insurance
    k. IoT – Internet of Things
    l. Legal
    m. Manufacturing
    n. Media and Entertainment
    o. Pharmaceuticals
    p. Retail
    q. Security, e.g., computers, networks, devices, etc.
    r. Supply chain and Logistics
    s. Trade
    t. Travel and hospitality
    u.

11. **Is your company currently deriving measurable benefits from AI applications it has deployed?** *Yes, it Exists. The core business is based on AI technologies which allow us to drop cost due to automation.*

12. **How deployment of AI applications transformed the way your company operates?** *It is the core business. Processes are automated, more reliable and precise.*

13. **What are the biggest adoption challenges to your company's efforts to utilize AI?** (Please select all that apply.)
    a. AI is still an emerging technology
    b. Lack of understanding just what AI can do/is good for
    c. Identifying applicable use cases that are relevant, cost-effective, and practical to implement for our particular business or industry
    d. <u>Lack of available experts skilled in AI</u>
    e. Lack of industry standards and AI methodologies
    f. Regulatory constraints
    g. Privacy and security considerations
    h. Transparency and "fairness" issues, i.e., AI algorithms could be biased and may not be transparent in their decision making (organizations could find it difficult to explain the reasoning behind a decision)
    i. Security considerations
    j. Limited market for available AI solutions
    k. Employee resistance, i.e., fear of being automated out of their jobs, etc.
    l. Data integrity and management issues
    m. Don't know

14. **Is your company designing and implementing, or planning to design and implement, its AI applications in house, or will you use outside consulting firms specializing in AI design and implementation?**
    While it is hard to find experts because they are few and contented by big tech giants, we aim to develop internally our expertise. Two reasons: it is cheaper and we can have more control on it since it can constitute competitive advantage.

Department of Business & Management

Corporate Strategies

SUMMARY

Artificial Intelligence:

towards a new economic paradigm

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2017/2018

I. Definition

Artificial intelligence (AI) is finally providing a multitude of competencies to machines which were long thought to belong exclusively to the humans.
While the concept of AI dates back more than 50 years, only recently technological advances enabled successful development and implementation at industrial scale. However, the first idea of AI appeared a decade before with Vannevar Bush which imagined a "system" able to amplify the individual knowledge and understanding.[267] In 1950 Alan Turing was the first to write about "Computing machinery" and "digital computers" able to imitate human beings, both in acting and in cognitive skills.[268]
Artificial intelligence is a set of technologies that provide computers with cognitive skills, such as problem-solving, decision making, reasoning, as well as voice, image, and language recognition, which typically belong to human beings.
Thus, AI is about providing *machines* with *intelligence*, therefore, we have to define what a machine is. We can imagine it as a cold and complex arrangement of cables and mechanic system; however, nowadays the concept of machine is wider because of computers, systems composed of hardware and software. In the last decade, technologies evolved towards the fundamental human cognitive skills. While always more complex algorithms are able to drive a car in the traffic autonomously, sophisticated computers developed knowledge through data analysis which enabled them to learn. However, it is still not possible to forecast how far the artificial intelligence development can go and how close to human brain it will become. Today intelligent machines control cognitive skills better than humans in many fields, while still do not show any "emotional intelligence".
The field of the research is on the practical economic applications of artificial intelligence such as robotics, autonomous vehicles, computer vision, natural language processing, logistic planning, financial forecasting, and machine learning.

I.2. Applications

6. **Robotics and autonomous vehicles**.
7. **Computer vision** based on processing information from the external world. Computers can detect the presence of breast cancer watching mammography images.
8. **Natural Language Processing (NPL)** which studies the interaction between the human language and computers.
9. **Virtual agents.**

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10. **Machine learning,** the new frontier based the implementation of a computer program that improve with experience based on observation of data.

Human involvement, the science is developing four forms of AI with:

3. **Human involved**:
    a. *Assisted Intelligence*: AI systems assist humans in making decisions or taking actions.
    b. *Augmented intelligence*: AI systems that learn interacting with the external environment.
4. **No Human involved:**
    a. *Automation*: Automation of manual and cognitive tasks.
    b. *Autonomous Intelligence*: AI systems are able to adapt to situations and to act autonomously without human assistance.

I.3. Why now?

After decades of research and development, it is clear that in particular today the progress and the importance of AI is flourishing. This is related to the evolution of three key factors:

5. the expanded availability of **data**;
6. increasing of **cloud computing power**;
7. more powerful **algorithms**;
8. decreasing **storage cost**, from around $500,000 per gigabyte in 1981 to less than $0.03 per gigabyte today.

II. Economics of Artificial Intelligence

In this section are analyzed the economic effects of artificial intelligence diffusion. The disruptive impact of new technologies is studied through the analysis of the traditional economic agents which are the firms, householders, and institutions. However, today the diffusion of the Internet is erasing these traditional distinctions since consumers can be also suppliers, multinational enterprises are always more similar to national institutions while the same concept of nation and border is vanishing.
Anyway, the aim of this chapter is to explain in what way the AI revolution is already affecting the overall economy, in what dimension and, in particular, in which direction is going.

II.1 Artificial Intelligence and Enterprises

In this section, we are discussed the effects and implications that artificial intelligence-driven innovation has on firms and businesses.
AI constitutes a strategic competitive advantage reflexing on the growing revenues of the earlier adopter firms. Those firms are tech giants of which the stock value is skyrocketing as Apple, Google, Facebook, Amazon and many more.
The amount of their investments in AI research is extremely high and it evidences the extent of this innovation. Digital native companies like Baidu, Google or Facebook, for example, constitute the most advanced lines of the so-called "digital frontier" with investments that state around $20-30 billion only in 2016, while, in the last years, also venture capital funds are starting to invest more; numbers say more with that $4 billion of investments and more than $1 billion from equity funds.[269]
Many efforts have been made mostly by the biggest technology suppliers while for most of the companies AI is still in the development stage. There are not numerous products available on the market and adoption is for now limited. For this reason, experts are still divided about the real extent of AI innovative revolution, especially by an economic viability point of view. The proof of that is the high variance of investments detected on the market: few big investors while the vast majority seems not yet involved.[270]
Moreover, it seems that the scale of the company influences the degree of AI adoption since they are able to exploit successfully scale economies and leverage big volumes of investments. Furthermore, larger firms have access to the wider range and better quality of data, have more qualified employees.
Beyond the adoption, tech giants are draining competences and skills by absorbing all small startups through a process of M&A, called "acqui-hiring". This causes a lack of independent AI experts on the market and it raises their price. M&A is the main way tech giants use to fund and seize AI research.
Evidence suggests that the implementation of AI technology inside the core business leads to an impressive result. This is true especially for those companies that implemented AI as part of their core business.

II.1.a. Artificial Intelligence Business Application

These are the main areas where AI is applied:

[269] McKinsey, June 2017.
[270] McKinsey, January 2017.

- **Projection and forecasting** in order to and analyze demand trends, optimize supply. In the specific, the main benefits of AI-based approaches impact the supply chain management, R&D and the business support functions.
- **Produce** better goods and services reducing cost and enhancing quality;
- **Promote** products with the right messages to the targeted customer at the best price. Airline seat price is adjusted dynamically in relation to the time of the day, season and many other factors. It is called *yield* management mechanism: AI-powered algorithms analyze the vast amount of data in order to set the right price for the specific customer.
- **Provide** more personalized user experiences.

II.2 AI-driven automation and effects on labor

"Teachers will not be replaced by technology, but teachers who do not use technology will be replaced by those who do." Hari Krishna Arya

Could new technologies cause mass unemployment? How will change the nature of work? These are the question this part is aimed to provide a solution. While technological automation does improve productivity, at the same time, it erodes human competences and increases pressure on workers. This trend is enhanced by soaring income inequality.

Automation and AI do not take jobs, but tasks and competencies which are part of a job position. The degree which those specific tasks and competencies are automated does cause the total or semi absorption of a human job by machines. If all the tasks of a specific work position are automated, generally no human employees are needed. Equally, if the process of automation is partial, humans are still needed, time is freed and the work becomes integrated with new technologies. Directions are different but the result is always just one: the automation of tasks generates more efficiency.

Evidence suggests that often non-routine tasks are related to higher skilled workers while, the opposite is true for more routine works. The same is for wages that are indirectly correlated to the degree of routine. To higher wages corresponds lower degree of routine tasks.[271]
OECD analysis shows that less educated workers are under higher risk of automation than higher educated ones. In particular, there is a divergent effect on those workers who hold at least a bachelor degree which only 1% of them is likely to be completely automated while the percentage rises to 44% for those who do not hold any degree.[272]

[271] "Putting Tasks to the Test: Human Capital, Job Tasks, and Wages", David H. Autor and Michael J. Handel, The University of Chicago Press, 2013
[272] Melanie Arntz, Terry Gregory, and Ulrich Zierahn, "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis," OECD Social, Employment and Migration Working Papers No. 189, 2016

Advancing technology enables machines and robots to perform and automatize work tasks usually executed by humans. While the direct automation of tasks increases the pressure on routine and lower skilled jobs, the surge of Artificial Intelligence extended the range of tasks that can be performed by robots through algorithms and learning machine techniques. Thus, today, also "white-collar" jobs are under risk of automation since computers demonstrate human cognitive capabilities and, often, control them better than humans do.
This is particularly evident in the Wall Street Stock Exchange. Here, automated trade algorithms manage about the 70% of all stock market transactions. Operations that are not just mechanic executions of routine tasks but AI algorithms make forecasts and analyze the behavior of investors while trading a huge amount of stocks and pension funds.
However, while AI competences are expanding, it is not always true that their introduction on the workplaces means the disappearance of human employment. The issue is that the majority of jobs will be automated only partially and no completely. We are moving forward a new nature of work.

According to the Osborn, Frey model, around the 47% of jobs are under high and immediate risk of automation in the next 2 decades. However, it is not specified the quality of such automation which may be total or partial, which does not lead to layoffs but does increase the work performance.
OECD highlighted that the most of occupations are likely to change and be partially automated or supported, while only 9% of jobs are under risk of complete displacement.[273]
It is also true that 85% of 2030 jobs haven't been invented yet. Certainly, automation does displace workers but at the same time does create new opportunities while does not affect the total number of employment in the economy because of this kind of offsetting effects. Indeed, the direct application of AI technologies might enable indirect job creation to the degree it increases productivity and wages while rising consumption. This process allows the creation of new jobs across the whole economy and sectors. Another indirect effect of automation is the shift of the workforce from one specific occupation towards adjacent positions or markets. New workforce will be always more integrated with robots and machines. The same nature of work will change and evolve.
However, the flow of the higher economic value generated by new technological improvements is divergent and the majority is running directly towards the capital owners while the pressure is always more overwhelming on the vast part of workers.
We are experiencing a concentration towards the capital holders of the majority of the value created by the economy, while workers suffer the constant drop in their salaries. Thus the soaring inequality is not a direct result of the technologic innovation, but the

[273] M. Arntz, T. Gregory, U. Zierahn, (2016). The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis. OECD Social, Employment and Migration Working Papers No. 189

effect of the actual economic environment that is skewed designed. Its distorted evolution enhances biases and dysfunctions. This is happening because the current economic model is obsolete and it is not suitable for the emerging disruptive technology. While technology is evolving, as never before, it is necessary that also the economic model evolve or at least adapt to the new scenario.

II.3. The role of institutions

Policy and government play a fundamental role in shaping the effects and the direction of the technological change. While the AI disruption changes business models and drives the choices of firms and entrepreneurs in the economy, institutions are called to redesign boundaries and incentives in order to alleviate biases and unlock the potential of such innovation.
In general, there are three main approaches that can be pursued by policymakers in order to address the raising AI revolution. These paths may be no alternative:

7. **Invest in AI.** Investing in the development of AI means to control and direct the flow of innovation in order to unlock its potential and distribute benefits to all while alleviating the biases. The main issue is creating a positive environment by the creation of a collaboration between the government, authorities, universities, and firms.
8. **Re-educate workers for updated skills**. AI-driven automation are changing the nature of work and the skills required of employees. The adoption of AI will cause the displacement of millions of jobs while, at the same time, the rise in demand for new occupation with different skills.
9. **Capital endowment**. While everybody is born with an endowment of labor, everybody should also have born with a capital endowment provided by the government, a portfolio of financial asset. With some "lock up" restrictions, citizens would receive a portfolio from the government and he/she will be able to sell it, hold it or invest. the crucial issue of such policies is to help those displaced by automation but, at the same time, do not disincentive the research of other occupation.
10. **Social security aid for displaced workers**. Pursuing a social security aid for such workers and job seekers is a strategy directed to ensure the possibility to lift consumers demand and allow a more efficient job placement-
11. **Universal Basic Income**. Considered as an alternative to welfare state, it provides a basic income to the whole population, we focus on minimum universal basic income that is the one planned to guarantee a wage above the poverty level.
12. **Robot tax.** It can be realized also as a form of tax break for those firms that keep the level of human employment stable. The risk of the enforcement of robot tax would cause companies simply to move towards other countries.

III. Elaisian business case

Elaisian is a bright example of artificial intelligence integration as core of the business model. This business case is provided in order to support the study with the concrete story of a successful start-up which took through the new technologies the opportunity to grow. In particular, this company utilizes artificial intelligence applications such as machine learning and predictive algorithms in the food tech industry. The study and the information are provided through a numerous interview with co-founder and CMO Giovanni Di Mambro.

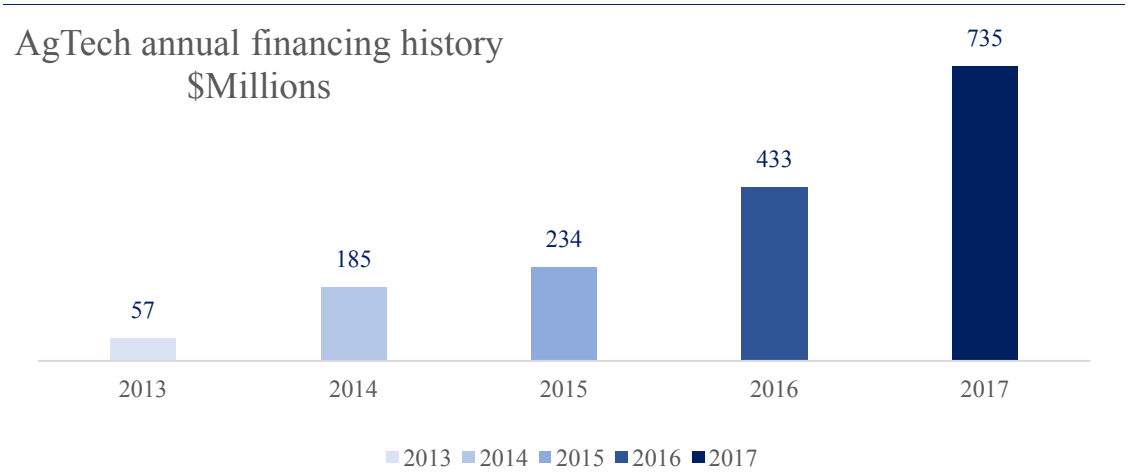
From a financial prospective, StartupBootCamp made the first investment of €15.000 and the 6 percent of company equity. This investment enabled the implementation of the first minimum viable product and the creation of commercial partnership and advisory from top manager of start-up ecosystem and European-Italian food industry. After three months of entrepreneurial path, Elaisian attended the "Demo Day" event in front of an audience of more than 300 investors. The event raised additional cash and investment which enabled the deeper improvements and a commercial development of the product.

Today the team is composed by 6 people, the CEO Damiano Angelici, CMO Giovanni Di Mambro, 1 agronomic expert, 2 IT engineers and 1 salesman. In July 2018 new funds were provided through a crowdfunding campaign on Mamacrowd online platform raising the amount of € 122.000. Elaisian is in 11 Italian regions with 50 olive oil farms and 80.000 olive-trees monitored.

The company developed the first ag-tech service in the world that prevent olive-trees diseases. Thanks to a system of algorithms, based on an agronomics database, the system enables disease prevention and cultivation processes optimization. Complex algorithms run by artificial intelligence provide continuous monitoring of field conditions and suggestions. In the numerous interviews with the CMO and co-founder, we demonstrate that intelligent technologies create concrete benefits and can be developed also by small firms. In particular, they drop significantly operative costs and reduce environmental impact. Moreover, machine learning, implemented in the company core business, enables algorithms to learn and refine their work autonomously without human intervention. This optimizes the process while guaranteeing precision and rapidity.

III.1. Market and competition analysis

Elaisian an agricultural business intelligence solution founded on in-field measurements. The company operates in the food tech industry providing business to business service in the agriculture pre-harvesting production phase. In particular, Elaisian is specialized on the olive oil production.

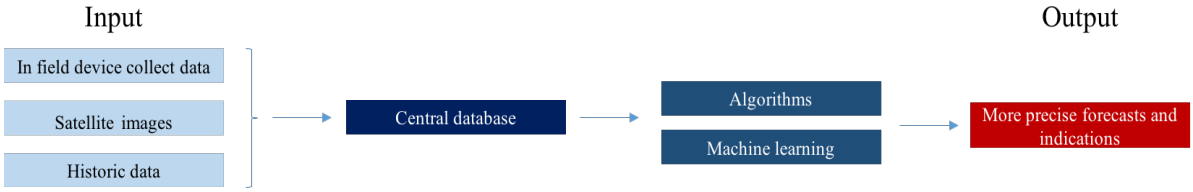


Source: FAO, Syngenta, Monitor Deloitte research, December 2017

Interests and expectations are growing in this market since the acquisition of "the Climate Corporation" by Monsanto for more than $1billion in the 2013. In the same year in the sector there were more than 300 unique investors and more than 160 deals, contrasting the 31 deals and less than $200 millions of investment in 2007.
However, Elaisian is specialized on the olive oil market. The company is the only firm specialized in Ag-Tech for olive oil production and it is established in Italy, the fourth largest olive oil producer and the second consumer in the world. There are 3,5 millions of oil producers, only in Italy there are more than 850.000, hobbyist included. The 75 percent of them is composed by small firms with up to 5 employees. The target of Elaisian are only the firms which constitutes roughly from 25 up to 35 percent of entire market.
The broader competitive landscape is dominated by the two largest players Dow/DuPont and Bayer/Monsanto which control diversified segments in the market. For what concerns Elaisian, the strategic market of reference is the in-field measurements through sensors. This highly competitive *sector* with a large number of start-ups. However, Elaisian is the only existing start-up specialized on olive oil. Furthermore, the geographic diffusion of olive trees delimitates the range.

III.a. Artificial intelligence and the Elaisian case

The decision to choose such firm is related to the elevated utilization of AI related technologies in the business value chain. In particular, Elaisian, has incorporated in its core business AI applications such as Machine learning technologies through which algorithms learn how to process data and provide more precise Predictive analysis.

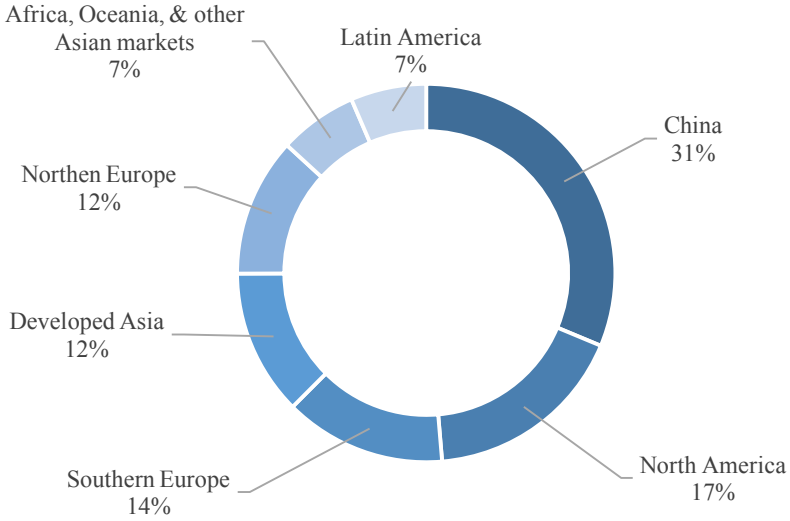


Elaisian AI applications are two: Machine Learning and Predictive Analytics applied through algorithms to the huge amount of data stored in the company database. The reason why Elaisian is interested in adopting such technologies is because the company "*system is all based on data collection and processing. In this sense both machine learning and predictive analytics are fundamental."* According to the CMO, Machine learning technology is the core of the firm value. *"This technology allows Elaisian to have a self-updating and more precise algorithms with reduction of personnel costs and maintenance; all process is automated".* We asked if these applications are projected and realized in-house or purchased outside. Mr. Di Mambro said that "*while it is hard to find experts because they are few and contented by big tech giants, we aim to develop internally our expertise. Two reasons: it is cheaper and we can have more control on it since it can constitute competitive advantage."*
He told us that the main difficulty is finding available experts skilled in AI. *"Investing in such technologies requires specific talent and expertise, it is hard to find experts."* This reflects the results of a survey by European Commission. To the question "which are the biggest roadblock to AI adoption by firms?" the 54 percent answered "lack of skilled people".[274]

IV. Artificial intelligence: the global challenge

$15.7 trillion, 14 percent of the world GDP, this is the value of economic benefit deriving from AI in 2030. $6.6 trillion deriving from increased productivity and $9.1 trillion the impact on the consumption side. The stakes have the weight to completely redesign the

AI's impact on GDP by 2030



[274] European Commission, Europe's Digital Progress Report (2017). Human Capital: Digital Inclusion and Skills.

global economic equilibrium. Many governments have settled a long-term strategy to gain the AI global leadership.
This means that, in the macroeconomic scale, developing countries may have the chance to overtake the most advanced economies. At a microeconomic point of view, startups have the possibility to hold a significant competitive advantage and take the market leadership, while the incumbents are under risk of collapse.
70% of the global economic impact of AI will be concentrated in North America and China.[275]

IV.1. Where does Europe stand?

Europe is lagging behind. While there is still not a continental AI strategy and a strong commitment to enhance and invest in AI, some Member State governments have developed their own national strategies. Europe has excellence research lab and expertise while the private sector is still slow in adopting AI technologies. Single member states, alone, have several natural disadvantages in order to compete with China and the United States: they cannot count on the same amount of data, AI adoption by private sector is still low and, alone they cannot scale up resources at the same level.
Thus, single national strategies are not competitive with the strength and the dimension of the two world largest economies and it is necessary an integrated European AI strategy.

IV.2. China and the United States: the global race for AI supremacy

The Chinese government has taken seriously the AI global race and it seeks to catch in for 2030 the world AI leadership. Today, North America and, in particular, the United States toughly hold the AI primate since the strength of its global leaders such as Google, Amazon, Apple, Microsoft and Facebook. However, there is a shocking amount of research indicating the gap is shrinking.[276] AI development will impact global economy with an increase of $15,7 trillion, $7 trillion of that are part of Chinese economy.[277]

China has three "natural" advantages on the United States:

4. Largest population on Earth, 1.4 billion. This provide wider amount of available data and the opportunity for companies to scale quickly.
5. Strong government influence.
6. Loose approach to digital regulation and lack of privacy protection. This allows companies to experiment without regulatory barriers.

In addition, China has four competitive advantages in respect to other countries:

5. Abundant data;

[275] PricewaterhouseCoopers. (June 2017).
[276] Greene T. (August 2018). China set to leapfrog US in the AI race. The Next Web.
[277] PricewaterhouseCoopers, 2018.

6. Hungry entrepreneurs empowered by new tools;
7. Growing AI expertise;
8. Mass government funding and support

While the Chinese AI giants (Baidu, Alibaba, and Tencent) are imposing their influence on Asia, there is an exploding number of startups and entrepreneurs that through the "copycat" strategy have learned the most advanced tech skills. The government of Beijing declared the country was home to 168 unicorns, companies valued more than $1 billion, worth a total $628 billion.[278] However, for now the gap is still huge. China does not have the same vibrant and vivacious AI ecosystem as the United States Silicon Valley, which is large, diverse and diffused between universities, private companies and research labs. For China it is hard to replicate the same AI ecosystem. Furthermore, the same verve is in the M&A campaigns of the American tech giants that is way higher than the Chinese tech firms.
At the same time, while AI Chinese expertise is growing, the US and UK research remains more influential. The United States publications are roughly the half of the Chinese ones but the former have almost double influence than the latter.[279]

The China's State Council issued a document in 2017 called "New Generation Artificial Intelligence Development Plan" (新一代人工智能发展规划) where the Beijing government sets an ambitious strategy to become the world leader in AI by 2030 and the purpose of making the national industry worth 1 trillion yuan ($147,7 billion).[280]
The main core of this strategy is the "intelligentization" (智能化) of the economy, the public administration, and the military.[281]

The gap between China and the United States is still wide, even if, in the last few years the situation has changed. This gap is shrinking, Chinese tech giants are investing more funds in AI internal research and in talent acquisition through an aggressive activity of mergers and acquisition all around the globe, supported by central government funds. At the same time, the Beijing government aims to become by 2030 the AI global leader considering such technology as the main factor for the economic growth and geopolitical power.
On the other side of Pacific Ocean, the United States AI ecosystem is the most vibrant AI environment in the world. American tech giants lead the AI research and development. Companies like Google, Amazon or Apple are the most diffused on the globe and, even if the competitiveness Asiatic firms is growing, they inject billions of dollars in AI

[278] Weinland D. (April 2018). China's Ant Financial shows cashless is king. The Financial Times.
[279] According to the H-index, a system that ranks the productivity of scholars and the impact and citations of their publications. Data from McKinsey, 2018.
[280] China State Council. (July 2017). 新一代人工智能发展规划 - A Next Generation Artificial Intelligence Development Plan. Beijing.
[281] Vincent J. (2017). China and the US are battling to become the world's first AI superpower. The Verge.

research in many more diversified and advanced fields than their rivals. What is certain is that the speed of AI development is strongly increasing led, not only by private companies but, also by national governments.
In the coming years, the key for the AI global race will be the ability of firms and governments, not only to invest but, also, to create collaboration and strategic agreements in order to leverage resources and exploit specializations.
What is certain is that, in the next decade, the global race for AI supremacy will not only deeply impact the economy but also the geopolitical weights on nations.